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"For the Gauls, having either perceived the track of a human foot where the messenger from Veni had climbed or having themselves marked the easy ascent by the rock at the temple of Carmentia, on a certain moonlight night mounted toward the summit, supporting each other and drawing each other up, all so quietly that the noise escaped the notice not only of the sentinels but of the dogs also. But the notice of the geese, sacred to Juno, they did not escape. The watchman, *being roused from his sleep* by cackling of the geese and the clapping of their wings, snatched his arms, rushed to the spot, struck with the boss of his shield the foremost Gaul who had already gained the summit, hurling him backward upon his fellows. And now the others, being assembled, poured javelins and stones upon those below, hurling them down the precipice in promiscuous ruin."

Livy V: 47.

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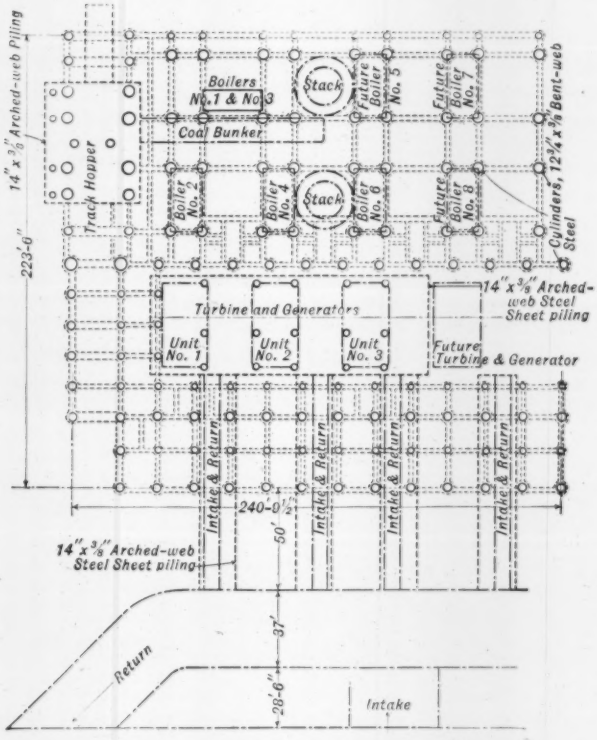
Designed and executed by Stone & Webster Engineering Corporation.

G. O. Muhlfield, Construction Engineer, S. L. Shuffleton, Western Manager in Charge, and E. C. Macy, Gen'l. Sup't.

This new 200,000-hp. plant occupying a Niagara River frontage of 1,040 feet by 600 feet depth, is built on ground less than 12 inches above normal level of the river, and consisting above bed rock, of 5 to 7 feet of soft mud and silt, below which is 25 to 28 feet of saturated quicksand, and 3 feet of clay containing large gravel and small boulders.

Quick completion of the plant demanded starting work in mid-winter and that little time be spent on the foundations, although they had to reach bed rock. Cylindrical piers were therefore constructed to carry all loads of the power building (240 feet long by 223 feet wide, floor about 5 feet above river level) including machinery, stacks, etc. These piers, 157 in all, varying from 33 to 81 inches in diameter and each designed for the load it was to carry were all built in open caissons of Lackawanna Steel Sheet Piling, this sheet piling remaining in permanent position as part of the finished structure.



Notwithstanding the bitterness of an exceptionally severe winter, the exposed location on the river and flooding of the foundation site, the work of assembling and driving the Lackawanna Steel Sheet Piling to a depth of 6 to 18 inches in bed rock was completed *in 70 working days*. The average time for driving was about 6 hours per cylinder, most of this being required to drive through the glacial drift and disintegrated rock just above bed rock.

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Engineering News

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Draining North Holland After January's Great Flood

By Jan Spaander*

North Holland, which with the Frisian Islands separates the Zuyder Sea from the North Sea, is partly a mudbank and partly a pit whose bottom is at or below the level of the ocean bottom near-by. It was reclaimed by man from shallow ocean waters, and now supports one of the densest populations in the world. The sea's erosion on the west and accretion on the east cause the whole peninsula to shift eastward at the rate of a mile in three centuries. This has made it of constant interest to the geographer and the engineer. Tremendous dike breaks on Jan. 14, 1916, in which the sea temporarily regained part of its former dominions, followed by remarkable and successful human work in restoring the "polderland" to its dry state, have again centered the world's attention on North Holland. The bottom of the North Sea is an extension of the gently sloping German plains. In prehistoric times a wide strip of the shallow beach waters was cut off from the rest of the ocean by the joint action of wind and waves, which threw up an uninterrupted sandbank from Cape Gris Nez in France to Cape Skagen in Denmark and blew it together into high dunes. The stretch of water inside the dune belt was soon transformed by the rivers into a freshwater lake.

The same actions can yet be seen along the Frisian Islands. The German Haffen on the shores of the Baltic, and, in a sense, the Australian lagoons, remind one of it.

The shallow lake between the dunes and the mainland was gradually transformed into soft marshland by dying water-plants. Storms and floods broke through the belt in several places, scouring lakes out of the soft marshland and refilling some of these again with rich clay. In this way the Zuyder Sea was formed in the thirteenth century, and the appalling losses at this time caused the people to combine to "polder" the land, to surround small areas with dikes and provide drainage. The means and ends employed to polder and to drain depended upon local conditions. Thus North Holland consists of sandy areas along the dune belt, sea-clay regions (the highest of which are level with high water), marshland (below mean sea level) and "lakes" or areas level with or lower than the bottom of the sea. To reclaim the higher clay lands hardly any skill was necessary. A simple inclosing dike built out from the dunes was sufficient. Sluices, self-opening to the outside, regulated the outflow of water. The few drainage channels supplied the earth to build the first dikes. The marshland and lower clay lands, however, required pumps to remove the water. The windmill (Fig. 1), which was utilized for this duty, is still extensively employed. The four-vane windwheel drives, through wooden bevel gearing, an Archimedes screw, also made out of wood. The whole mill can be turned against the wind by means of the pole brake and rope, as shown in the section. The water-lifting screw of the windmill lifts the water over the dike and discharges it into the sea or into an inside "bossomwater" (bossomwaters are the interconnected canals which surround polders and "dry" lakes).

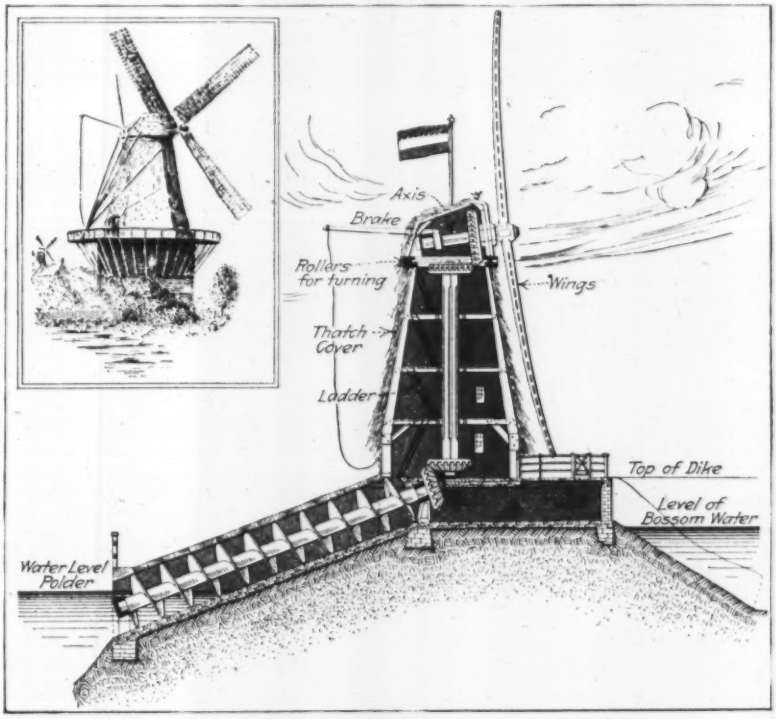


FIG. 1. SKETCH OF DRAINAGE WINDMILL

*618 45th St., Brooklyn, New York City.

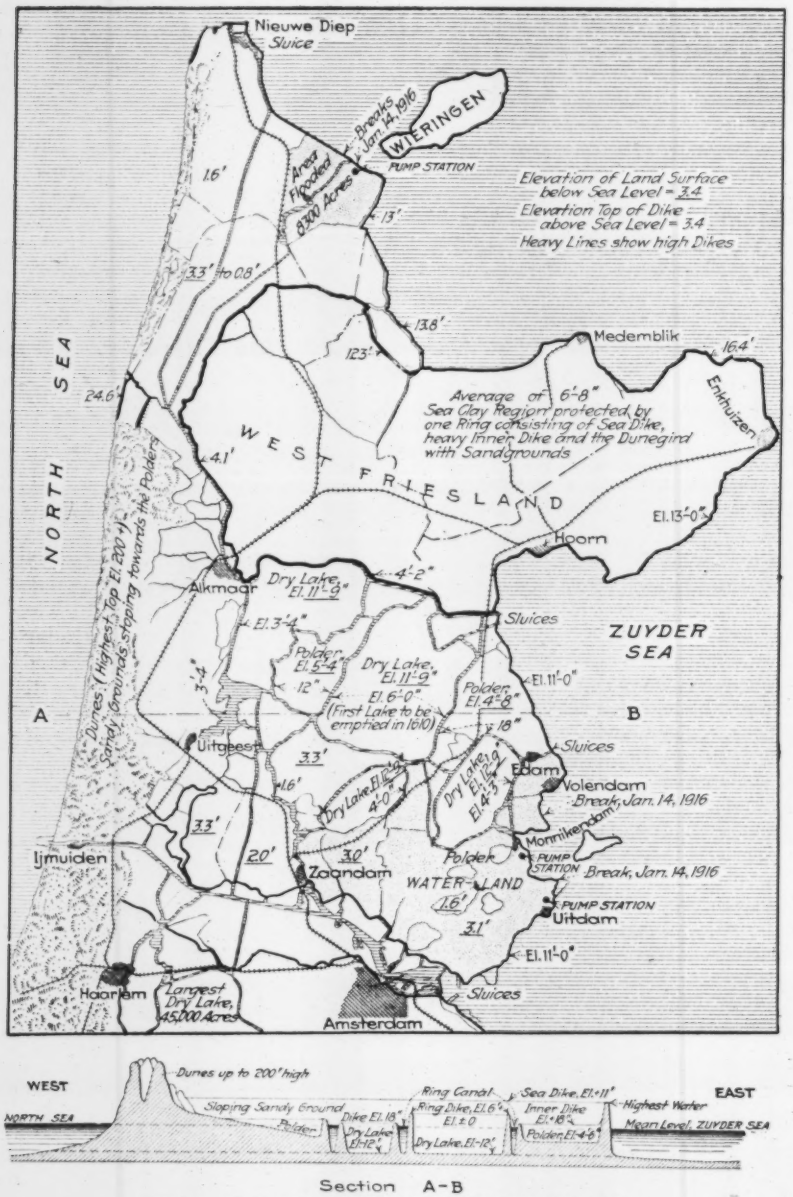


FIG. 2. MAP AND PROFILE OF NORTH HOLLAND

The aspect of a marshland polder is different from the high sea clay. The latter is provided with few canals, which often are dry. The polders, on the other hand, are traversed by substantial draft canals leading to the mills or more modern pump stations. Between, the land is divided by main canals, and then there is the endless subdivision by ditches, about 10 ft. wide and 100 to 200 ft. apart. The rectangular pieces of land thus formed are again divided by unlined gutters, but these are usually dry, their bottom being slightly above polder watermark.

This elaborate system of drainage works is kept in order by the farmers, and they are so convinced of the danger of the surrounding sea that they themselves impose heavy fines for slight shortcomings in this work. As the land has been formed by the water, it is plain that all tracts of one polder are at the same level.

The last areas taken from the sea were the lakes. An engineering genius born in the sixteenth century was much troubled by the "moving" of Holland. The dunes rolled landward and had to be stopped by means of plantation. The lakes and the Zuyder Sea grew land on the west side, just as it still happens today, and the storms broke it away on the east shores. An old Roman castle, now in the North Sea, proves that the average speed of the movement of the country was 1 mi. in three centuries. Leeghwater (empty water), that was the appropriate name of the engineer, offered to empty the lakes, and it was his luck that an obscure sea captain, by the name of Pete Hein, captured the Spanish silver fleet, bringing in such unheard-of wealth that the "crazy" project could be carried out. The reclamation of the lakes left Holland as shown by the map and profile, Fig. 2. Every polder and every dry lake is surrounded by a dike and a ring canal. These ring canals are all interconnected and together form the bossomwaters to store the water in till outside tides allow drainage through sluices, which also serve shipping. That the inhabitants always have been aware of the great danger of living in such a pit is best demonstrated by several "stretches" of cities and villages along inner dikes. This secures them against direct drowning in case of floods, and this accounts for the ease with which tens of thousands escaped the recent flood disaster. On Jan. 13, 1916, western storms drove the North Sea water into the narrow bottle-neck of the Zuyder Sea and filled the latter to the brim. An inside storm of more northern direction attacked the dikes, which are not built to withstand this very extraordinary combination. The typical dike, shown by Fig. 7, comprises a sand core covered by a clay mantle, the lower two-thirds of the outside slope paved with large stones. It is not designed to be overtopped. In January the waves rolled over the top, tearing out the soft inner slope. The view, Fig. 3, shows the result—the outside of the dike still standing, but the inner slope washed out.

The inrushing water churned deep holes in the soft marshland and widened the initial holes to from 10 to 430 ft. The adjacent polders were filled within a few hours. The village of Volendam, 3,000 inhabitants, partly built in a small dry lake, was submerged to the roofs (see Fig. 4) within two hours after the church bells all over the country sounded their warning. The polders not directly affected were filled up by secondary flooding; after the bossomwaters were loaded to the tops of the inner dikes, the low polders filled as rapidly as a saucer pressed down in a bucket of water.

The two main sections flooded, shaded in the map, Fig. 2, have areas of 35,000 acres and 8,300 acres. That

FIG. 3. A DIKE BREAK; INNER FACE SCOURED OUT BY OVERFLOW

and building large pumping stations to pump out the rest of the water.

The many breaches in the dike had to be closed. In many cases the rapid current through the breach had scoured out a deep hole, sometimes over 40 ft. deep. On this account the first closure was made not in the breach itself but by a semicircular inclosing dike built in the sea outside the breach.

On account of the constant flow of current in or out, the sand which was to form the core of the dike had to be held by brush mattresses. These are usually about 135 ft. long, 35 ft. wide, and 16 in. thick. They are woven along shore, floated out to their site, loaded with stone and sunk. The current soon fills them and covers them

FIG. 4. THE FLOODED VILLAGE OF VOLENDAM

FIG. 5. DIKE REPAIR IN PROGRESS

the bigger lakes did not fill is due to the strength and height of their dikes. The polderland behind Zaandam was saved by building several miles of miniature cofferdam along the Zaandam River, of parallel plank walls with clay filling between.

The great dry lakes now were threatened with disaster if even a slight eastern storm should occur. Their inhabitants already had fled, taking their cattle with them. The chief engineer of the Water State, Mr. Reigersberg, saw that quick action was needed to save these lands. There was no time for the usual formalities of letting contracts, but direct arrangements were made with private concerns.

The work to be done included repairing the dikes, draining the water to mean sea level through the sluices with sand; then a new mattress is sunk over it, to be followed by a third and sometimes a fourth, the latter being built in place since the sand is then already above low water.

Except for the sand deposited in and over the mattresses by the currents, the sand for the main structure of the dike had to be brought from the higher portions of the Netherlands, being carried by barge to Monnikendam and from there by temporary railways along the dikes to the place where needed. The same is true of the clay required for the outer faces. Above the mattress base the sand core was covered on both slopes by heavy layers of clay built up to 7 ft. above mean sea level and the lower part of the sea slope was paved with stone.

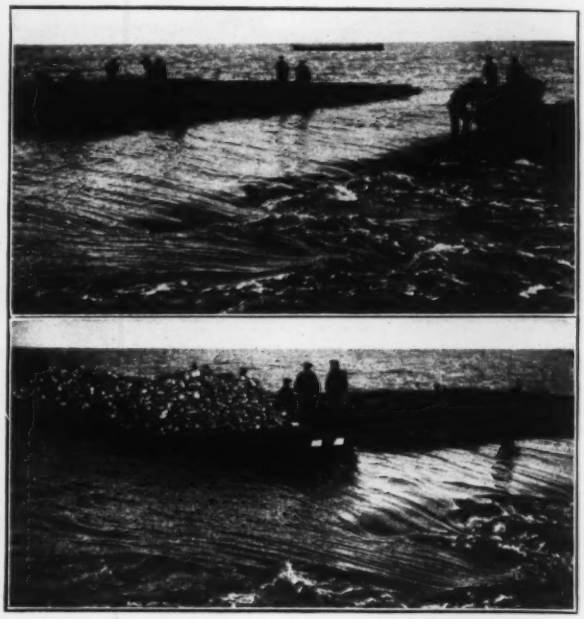
FIG. 6. SEAWARD VIEW OF KATWOUDE BEACH, WITH MATTRESS WORK IN PROGRESS

During the closure operations a small opening was left in the closure dike acting as an outlet sluice. This hole was closed at a favorable low tide.

The emergency closure dikes completed, no time was lost in filling the breach in the regular dike and reinforcing the entire length of dike whether damaged or not. The dikes are being made higher and are also being strengthened by an inner berm along which is carried the roadway formerly run along the top of the dikes. This berm and roadways are expected to be an important protection against washouts from overtopping in future.

As soon as the dike repairs were well under way, draining through the several outlet sluices at the ends of the bossomwaters started, the speed of the current being as high as the canals could stand. The outside tides were not altogether favorable for the work, and near Amsterdam three large suction dredges, of combined capacity 27,000 cu.ft. per min., were put in action to spout the water over the dikes.

In the meantime large pumping plants were built and erected. The Werkspoor Co., builder of a well-known marine Diesel engine, headed a combination of manufacturers to carry out this part of the work.



FIGS. 11 AND 12. FLOATING MATTRESS TO PLACE AND LOADING IT FOR SINKING

How the Pumping Problem Was Solved

A superficial calculation made it clear that the existing pumping stations were entirely inadequate. Those of the southern section, Waterland, for example, had an aggregate capacity of 28,000 cu.ft. per min. The total water to be removed from the surface of Waterland below the lowest level of sluice drainage amounted to 3,500,000,000 cu.ft., exclusive of the contents of the smaller dry lakes. If the drainage was to be completed within three or four weeks, a pumping capacity for Waterland of at least 105,000 cu.ft. per min. was required. The first two questions which arose were: Is it possible to build suitable pumps of such large capacity within a few weeks? Can motive power be provided? Within four days Werkspoor offered the authorities a design of large centrifugal pumps, which could be built and put

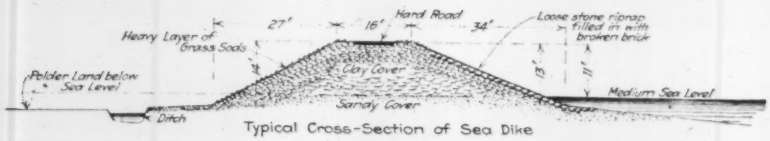
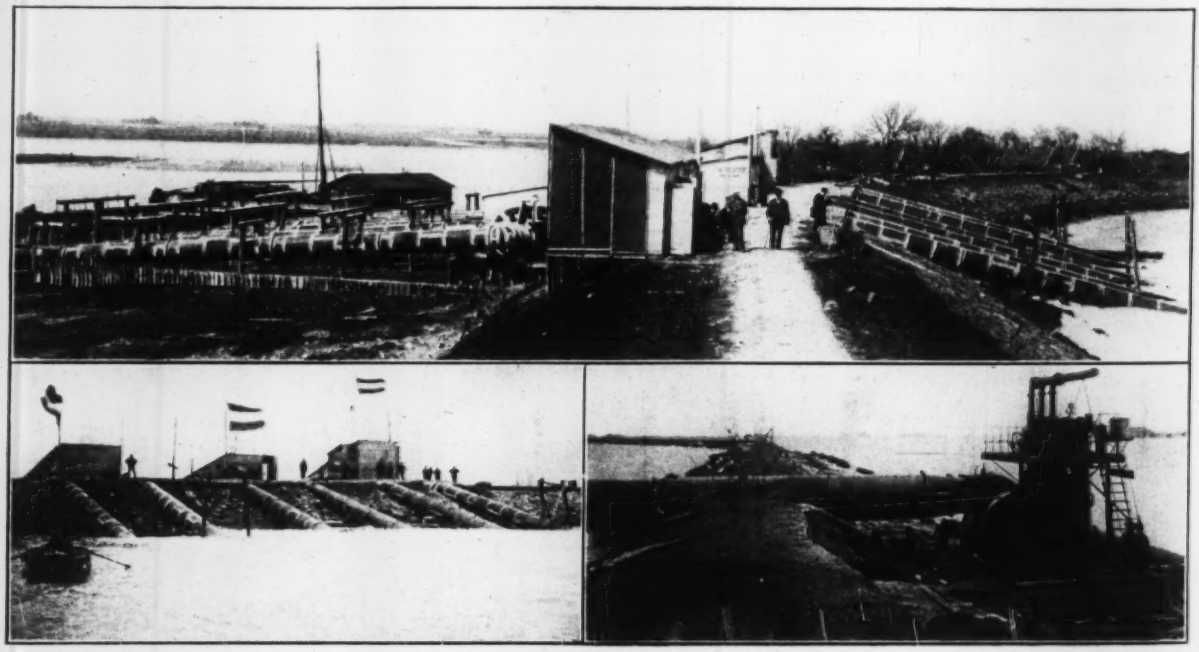


FIG. 7. SECTION OF SEA DIKE



FIGS. 8 TO 10. HUGE TEMPORARY PUMPING PLANTS

Fig. 8—Three-unit plant at Uitdam. Fig. 9—Full-capacity discharge, Uitdam. Fig. 10—Diesel-engine plant, Northern Polder

in action inside of four to five weeks. The Kennemer Electric Works had enough cable on hand to reach Waterland from the Amsterdam municipal electric station. Motors offered by manufacturers decided the size of units:

The 48-in. suction and 40-in. discharge for the pumps were made out of ¼-in. riveted sections. The pumps have all a one-side suction intake. Two pumps are mounted on one shaft carried by the two spherical cover bearings and

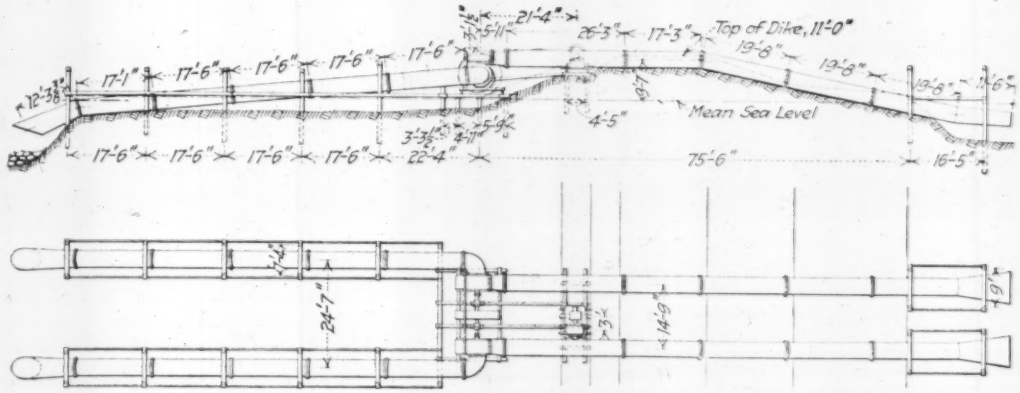


FIG. 13. CROSS-SECTION OF MONNIKENDAM EMERGENCY PLANT

One group of pumps was to be driven by a 300-hp. motor, one by two 160's, and the other two each by a 250.

On Feb. 8 the government accepted the Werkspoor proposal. The few weeks available excluded all complicated castings. The main parts had to be built out of steel sheets and rolled sections (see Fig. 14).

The casing sheets, $\frac{13}{32}$ in. thick, were joined by flame welding, which insured tightness under the condition of vacuum operation. The casing was stayed against the inward pressure by stay-bolts and stiffeners. Cast-iron covers, clamped together by through bolts, closed the openings through which the impeller was inserted. The one cover serves as collar for the suction elbow; the other cover carries the bearing of the impeller shaft. This latter has a spherical seat, which makes the alignment of the shaft independent of the casing, so that the latter could be adjusted to position after the shaft was lined up in all four bearings. To prevent any air entering at the

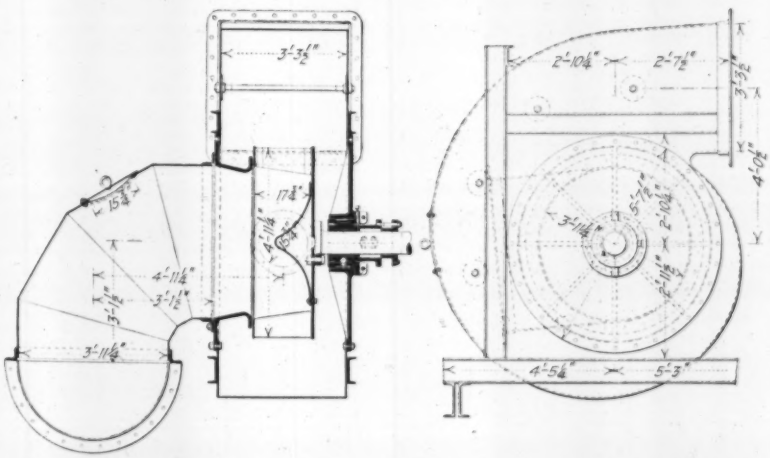


FIG. 14. SPECIAL CENTRIFUGAL PUMP BUILT FOR EMERGENCY DRAINAGE

spherical socket a rubber gasket in a V-groove is used as packing. There was not the slightest heating found.

The shaft is flanged to carry a ⅞-in. steel disk provided at the center with a cone of ¼-in. sheet. The impeller blades, slightly curved, are riveted to the disk by means of angle iron.

two center bearings alongside the main pulley. The interconnection neutralizes the axial pressures of the pumps. The pumps were kept apart by channel-iron framing, and this whole unit was carried by four heavy wooden beams. Sixteen piles 30 to 50 ft. long completed this light foundation. The vacuum in the pumps for starting was produced by small electric air pumps, and though this took several hours there was no objection.

One of the two larger groups, placed near Monnikendam, is shown by Fig. 13. The remaining three groups were put near Uitdam (Figs. 8 and 9), where wide existing main "drafts" supplied ample opportunity for suction at top speed. The capacities of the pumps were 7,000 and 4,900 cu.ft. per min. at a head of 3 ft. 4 in. However, at the beginning the head was smaller, and the aggregate output was in excess of 50,000 cu.ft. per min. The progress of the work is best indicated by the dates. On Feb. 8 the work was started; on Feb. 17 the outfit was ready for erection in the Werkspoor yard, and on Mar. 2 the pumps were ready for shipment. Transportation was by flat-bottomers; the riveted pipes were closed at the ends and floated to their destination. On Mar. 31 the pumps started pumping. This was by no means all the work done. The shipyard Conrad in the meantime had built a similar pump of 10,500 cu.ft. per min., with 60-in. pipe, to be driven by a 300-hp. Diesel engine. This outfit was for the northern section, the Anna-Paulona Polder, which could not be reached by electric cable on hand. This pump was similar to the others; but it had a two-sided intake, and the impeller had fan blades on either side to do away with axial forces. This unit was set on a foundation of 40-ft. piles. Its transportation and erection constituted a difficult feat.

Three smaller pumps, of 2,800 cu.ft. per min. each, were built for the deeper lakes in the Waterland polders.

By May 1 all the polders had been drained. Before the end of the same month the lower lakes were also emptied. The smaller flood of 1825 took over 1½ years to drain.

Placing a Steel Frame in an Old Wall-Bearing Building

The recent reconstruction, at Lincoln, Neb., of a six-story wall building with interior timber framing into a fireproof steel-frame building with concrete floors was a piece of work which involved several interesting engineering problems. The building is the home office of the Security Mutual Life Insurance Co. The contractor for the steel erection, which included foundations and all important structural problems, was John Westover, Inc.

The owners decided to reconstruct the building, preserving as much as possible the old walls. It was also decided to work on but one-half of the building at a time, so that the other half could be occupied during reconstruction. These schemes were followed out though subsequent experience showed there was little if any economy in them. Because of the timber frame bay-windows, little of the original walls was utilized (dark portions, Fig. 3).

The chief problem was one of foundation. Owing to the subsurface structures and other complications the wall footings could not be extended under the street, so that the new wall piers had to be set inside the old walls and on foundations of I-beam grillages and concrete. Details of the column footings are shown in Fig. 2 together with a plan of the foundations for the entire structure. Because of the insufficiency of the pier footings the upper two stories of the structure are cantilevered from the interior columns.

The scheme of reconstruction was to convert the existing six stories into eight stories and to add two more stories. The existing floors were left in place except such places as had to be removed to erect the steel framework, or were occupied by the steel. A 92-ft. steel-boom stiff-leg derrick was erected on the roof, so that its load

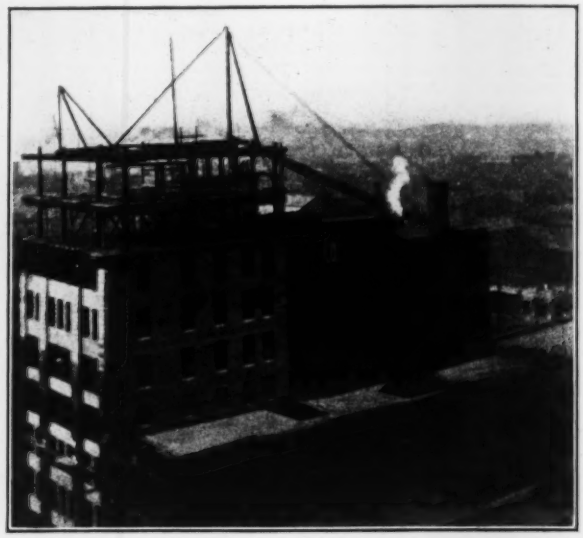


FIG. 1. RECONSTRUCTION OF SECURITY LIFE BUILDING, LINCOLN, NEB.

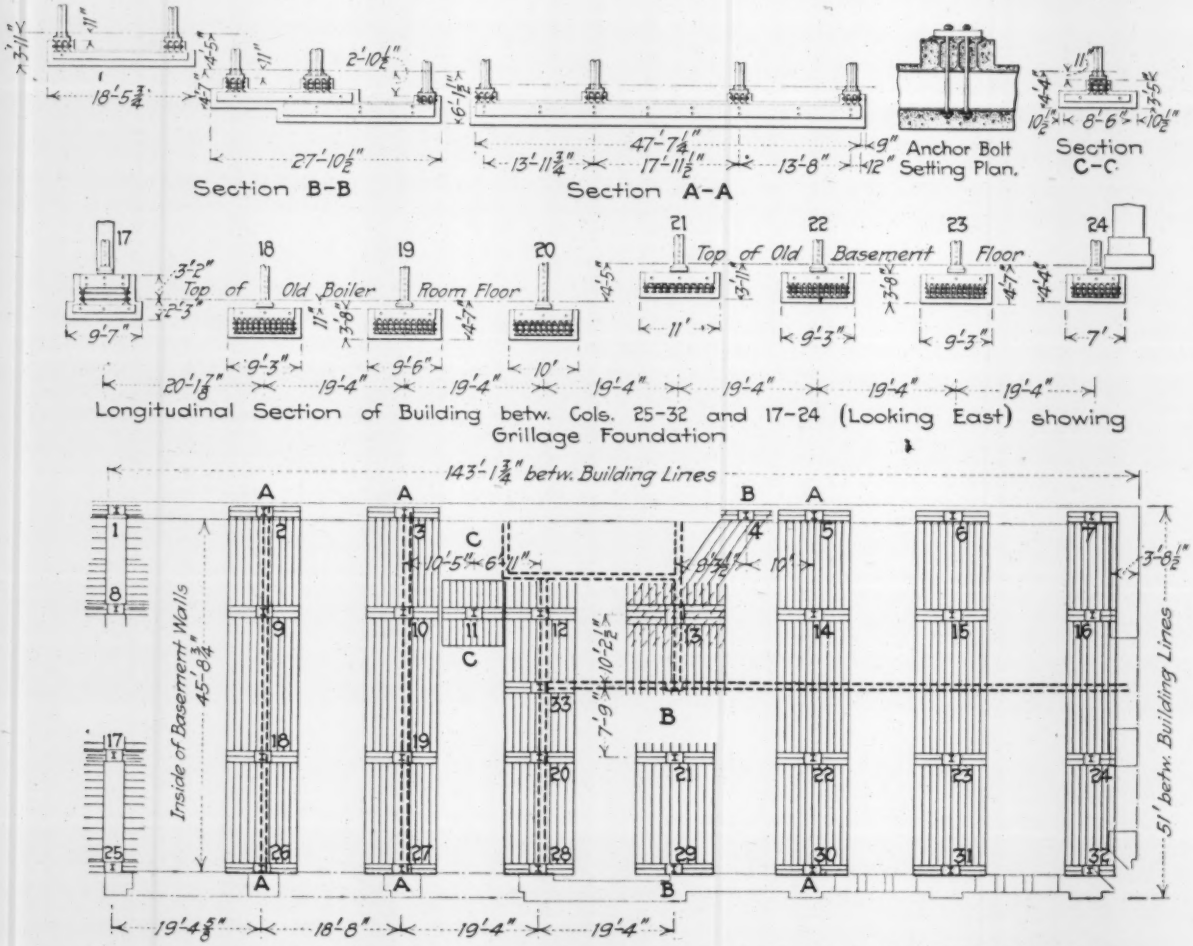

Section B-B
Section A-A
Anchor Bolt Setting Plan.
Section C-C
Top of Old Boiler Room Floor
Top of Old Basement Floor
Longitudinal Section of Building betw. Cols. 25-32 and 17-24 (Looking East) showing Grillage Foundation
143'-1¾" betw. Building Lines
Inside of Basement Walls
51' betw. Building Lines

FIG. 2. DETAILS OF FOUNDATIONS FOR NEW STEEL FRAME; SECURITY LIFE BUILDING, LINCOLN, NEB.

FIG. 3. RECONSTRUCTED HALF OF BUILDING

FIG. 4. HALF OF ORIGINAL BUILDING

was carried on the outside and partition walls. The legs were anchored by steel cables to the frame of the building several stories down. The steel was delivered in an alley behind the building and the 92-ft. boom was necessary to reach from the half of the building under construction completely over the old half of the structure.

When the foundations had been prepared, the steel frame members were hoisted to the roof and let down into place through holes cut in the roof and floors. The steel frame was thus placed before the old floors were removed. In the first half of the building reconstructed, partition walls were so arranged as not to cause serious inconvenience during the erection of the steel, but in the second half of the building, as shown in Fig. 2, the partition walls had to be removed first and the old floors carried temporarily on falsework.

Deep-Well Condensing Water

Deep-well water has occasionally been used for supplying condensers. The temperature of such water is practically constant the year through, and averages about 60° F., being perhaps a few degrees cooler in northern latitudes and slightly warmer in the south. With this nearly constant temperature the condenser may be considerably smaller, and the quantity of water circulated may be considerably less than where cooling towers are used; and probably it will average less the year round even where river water is at hand for condenser purposes. The first of these gains will reduce both the investment cost and the fixed charges on the condenser equipment. The second may not only bring about a greater saving in the amount of power required to operate the condenser apparatus, but may also result in a higher vacuum being maintained, which in these days of the steam turbine and the struggle for the last fraction of an inch of vacuum obtainable to increase the efficiency of the turbines served, will warrant an investigation as to whether well water is available for the purpose. In a number of cases the possibility of marked advantage has been disclosed.

It is stated that water recooled for condenser use, either by the use of the spray nozzle or by cooling towers, will rarely average better than 85° F. through the six summer months, and condenser capacity must be provided amply large for this temperature even though the yearly average temperature is less. With the best cooling tower or spray plant a vacuum of over 26 in. is rarely maintained in the summer time, and about 27 in. in the cold months, whereas with 60° water and a much smaller condenser equipment 28 to 29 in. of vacuum may be had in summer as well as in winter. The gain in efficiency may not only warrant additional investment in the cooler water supply, but may also warrant the pumping of the reduced amount of water against approximately three times as great a head as that used in the average cooling-tower installations.

Several such installations have been made by the Layne & Bowler Co., of Memphis, Tenn., and Mr. Layne states that an installation of this kind made about 16 years ago (where the deep-well pump is operated by belt power from the main compound condensing engine) is operating as efficiently today as when first installed. He suggests that many plants (especially in the South) which get along very well during the winter on lake, pond or river water, might profitably augment their supply for the hot months by means of deep wells. At a plant of 7,000,000 gal. capacity for cooling water, now being installed in Ohio, investigation showed that the temperature of the surface water in summer averages 80° while that of the well water is only 50°.

Aids To Estimating the Cost of Vitrified Pipe Sewers

By W. G. Kirchoffer*

The computations necessary for making an estimate for a pipe sewer of given diameter and depth have not, as a rule, been made by means of formulas and diagrams. Numerous attempts have been made to show these relationships on a single job or locality by means of diagrams. Coffin and Warren, independently, prepared diagrams of work done in Massachusetts (*Engineering News*, Jan. 2, 1896, page 2); and the firm of Riggs & Sherman, of work done in Michigan, Indiana and Ohio. Charles P. Chase, Clinton, Iowa, has derived constants for fixed costs. All these diagrams and tables were based on local work and provided no means of varying the estimate according to soil and other local conditions.

As long ago as 1901 I prepared and published a diagram, similar to the ones mentioned above, for the cost of sewers 6 to 20 in. in diameter and from 6 to 18 ft. deep, by plotting some 300 prices on sewers wherein the depth and size were known. (Copyrighted in 1901; published in the *Wisconsin Engineer*, January, 1901, p. 67.) This diagram was found useful as a means of comparison between the cost of sewers for different sizes and depths, but there was no means of taking into consideration the variations of soil, price, etc., as above referred to.

Later I found that all the data of my diagram could be represented by a single formula, with a factor which could be varied to suit the variations in soil and other conditions. In this formula

C = The cost of sewer in cents per foot;
D = The depth of sewer in feet;
S = The diameter of sewer in inches;
X = A factor dependent upon the character of the soil and method of handling it.

$$C = X\left(\frac{D^2 + 10S}{53 - S}\right)$$

Table 1 gives the values of the functions in the parentheses for various values of S and D. That is to say, the cost of any sewer of size and depth chosen is equal to X times the table factor for these conditions. To estimate the cost of any sewer, choose a value of X as described later and multiply it by the table factor. For illustration, the table factor for $S = 8$ in. and $D = 9$ ft. is 3.5. If X is chosen as 20 the cost per foot is 3.5×20 or 70c.

*Sanitary and Hydraulic Engineer, Madison, Wis.

TABLE 1. CONSTANTS FOR ESTIMATING COST OF PIPE SEWERS IN CONNECTION WITH LOCAL VARIABLE, FACTOR X*

Depth of Trench, Feet	Size of Pipe, Inches						
	6	8	10	12	15	18	20
4.0	1.60	2.10	2.70	3.30	4.40	5.60	6.50
4.5	1.70	2.20	2.89	3.40	4.50	5.70	6.65
5.0	1.80	2.30	2.90	3.50	4.60	5.80	6.80
5.5	1.90	2.40	3.00	3.65	4.75	5.95	6.95
6.0	2.00	2.50	3.10	3.80	4.90	6.10	7.10
6.5	2.15	2.60	3.20	3.95	5.05	6.30	7.30
7.0	2.30	2.80	3.40	4.10	5.20	6.50	7.50
7.5	2.45	3.00	3.60	4.30	5.40	6.70	7.70
8.0	2.60	3.20	3.80	4.50	5.60	6.90	7.95
8.5	2.80	3.40	4.00	4.70	5.85	7.10	8.20
9.0	3.00	3.60	4.20	4.90	6.10	7.40	8.50
9.5	3.20	3.80	4.40	5.10	6.35	7.70	8.80
10.0	3.40	4.00	4.60	5.30	6.60	8.00	9.10
10.5	3.60	4.20	4.80	5.50	6.85	8.30	9.40
11.0	3.85	4.40	5.05	5.80	7.10	8.60	9.70
11.5	4.10	4.65	5.30	6.10	7.40	8.90	10.00
12.0	4.35	4.90	5.60	6.40	7.70	9.20	10.40
12.5	4.60	5.20	5.90	6.70	8.05	9.50	10.30
13.0	4.85	5.50	6.20	7.00	8.40	9.90	11.20
13.5	5.10	5.80	6.59	7.35	8.75	10.30	11.60
14.0	5.40	6.10	6.85	7.70	9.10	10.70	12.00
14.5	5.70	6.40	7.20	8.05	9.50	11.10	12.40
15.0	6.00	6.75	7.55	8.40	9.90	11.50	12.80
15.5	6.35	7.10	7.90	8.75	10.30	11.90	13.30
16.0	6.75	7.45	8.25	9.15	10.70	12.40	13.60
16.5	7.10	7.80	8.65	9.55	11.10	12.90	14.30
17.0	7.45	8.20	9.05	9.95	11.50	13.40	14.80
17.5	7.80	8.60	9.45	10.35	12.00	13.90	15.30
18.0	8.15	9.00	9.85	10.80	12.50	14.40	15.80
18.5	8.55	9.40	10.25	11.25	13.00	14.90	16.40
19.0	8.95	9.80	10.70	11.70	13.50	15.45	17.00
19.5	9.35	10.20	11.15	12.20	14.00	16.00	17.60
20.0	9.75	10.60	11.60	12.70	14.55	16.55	18.20
20.5	10.20	11.10	12.10	13.20	15.00	17.10	18.80
21.0	10.65	11.55	12.60	13.70	15.50	17.70	19.40
21.5	11.10	12.00	13.10	14.20	16.10	18.30	20.00
22.0	11.55	12.50	13.60	14.70	16.70	18.90	20.70
22.5	12.05	13.00	14.10	15.20	17.30	19.50	21.40
23.0	12.50	13.50	14.60	15.80	17.90	20.20	22.10
23.5	13.00	14.00	15.10	16.40	18.50	20.90	22.80
24.0	13.55	14.55	15.70	17.00	19.10	21.60	23.50
24.5	14.05	15.10	16.30	17.60	19.70	22.30	24.20
25.0	14.55	15.65	16.90	18.20	20.40	23.00	25.00
25.5	15.10	16.20	17.50	18.80	21.10	23.70	25.80
26.0	15.65	16.80	18.10	19.40	21.80	24.40	26.60
26.5	16.20	17.40	18.70	22.00	22.50	25.20	27.40
27.0	16.75	18.00	19.30	22.70	23.20	26.00	28.20
27.5	17.35	18.60	19.90	22.40	23.90	26.80	29.00

*X = factor dependent upon nature of work.

Those who are not familiar with the use of such a table may be materially aided by working backward from data on previous work they have done, as follows: A contractor has laid a 10-in. sewer 8 ft. deep at a cost of 65c. per ft., and he now wishes to bid intelligently upon a 12-in. sewer 9 ft. deep. The table factor for the 10-in. sewer 8 ft. deep is 3.8; $65 \div 3.8 = 18 = X$. If the work on which he wishes to bid is of the same character he should use 18 as a value of X, but if the work was estimated to be 10% more difficult, then he should use 19.8 for X. The table factor for a 12-in. sewer 9 ft. deep is 4.9. The estimate would then be $4.9 \times 19.8 = 97$c.

The relationship of the factors in the formula are also shown by the accompanying diagram. The diagonal scale at the right shows the magnitude of the factor which is to be chosen for the particular piece of work, and is the same as X in the foregoing formula for the cost of sewer.

Suppose it is desired to estimate the cost of a 12-in. sewer 10 ft. deep, assuming a factor of 22. From the intersection of the vertical line through 12 in. with the horizontal line through 10 ft. pass diagonally upward to the right, parallel to the diagonal lines sloping upward in the direction, until the line marked 22 (sloping downward to the right) is intersected. Then pass vertically down to the bottom of the diagram where we read $1.16 per ft. In some problems the factor line will lie below the intersection of size and depth lines, in which case it will be necessary to pass downward to the left in place of upward to the right.

The selection of the factor must be based on the character of the work, current prices for labor and materials. In my own practice a determination has been made from work already constructed by working backward after the contract has been let.

To show how closely work may be estimated the following facts are given: At Antigo, Wis., the estimate on two miles of 24-in. intercepting sewer was $19,888, and the contract was let for $19,885. At Prairie du Chien, Wis., 25,110 ft. of 6-, 8-, 10- and 12-in. sewers were estimated by this method at $20,116, and the contract was let for $20,482. At Boscobel, Wis., 15,600 ft. of 8-, 10- and 12-in. sewers were estimated to cost $15,215 and the contract was let for $15,350. At none of the above places was the estimate given out previous to the closing of the bids.

For Wisconsin conditions, where the excavation is made in gravel clay with no water or quicksand, I have found that a constant of about 20 gives close results. In sandy soils and shallow trenches where sheeting was not required, a constant as low as 15 has given an estimate equal to the contract price.

TABLE 2. VALUES OF X DERIVED FROM LOCAL CONDITIONS

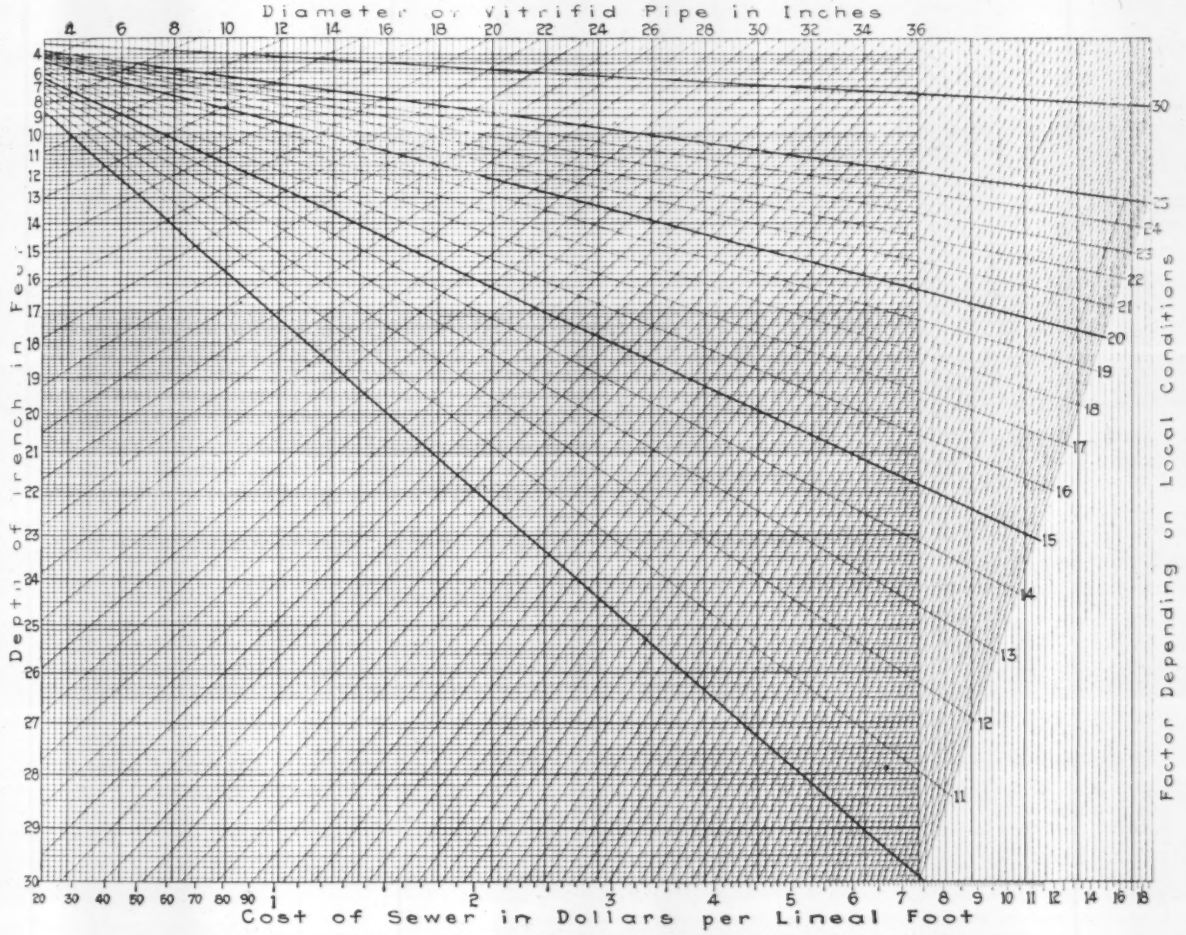
Location	Factor From	Factor To	Character of the Soil and Condition
Medford	22	26	Clay, gravel and boulder; wages high
Richland Center	21	22	Mostly sand, deep trenches, sheeted; wages medium
Kiel	15	20	Sandy clay; wages medium; labor conditions good
Mauston	14	20	Sand, sandy clay, some water; labor conditions good; pipe prices medium
Burlington	13	22	Gravelly clay, ¼ laid in concrete
La Farge	17	23	Sandy clay, some water, sheeting
Sanatorium, Wales		35	Clay, 2 mi. inland; have to board laborers
Plymouth	20	27	Clay, gravel and boulders
Lake Mills	16	19	Sand, clay and good digging
North Milwaukee	20	24	Red clay, machine work
West Salem	17	19	Good digging; wages medium

Table 2 shows the factors that have been computed from the cost of actual work done at the cities named. From the data of Table 2, the conclusions are drawn which are expressed in Table 3.

TABLE 3. VALUES OF X FOR GIVEN SOIL CONDITIONS

	Factor
Sandy soil, bracing only required, no water, wages and pipe prices medium	14
Good digging in any soil; work scarce	15
Clay soil, good digging	17
Red clay, no bracing	20
Sandy clay, some water	23
Sand with water	20
Red sticky clay	24
Gravel and boulders; wages high	26
Clay, gravel, lots of boulders; labor scarce	32
Work inland from railroad; board of laborers and other incidental expenses	35

Where the data given would not meet the conditions, but the size, depth and cost per foot of similar work are known, one can work backward from the cost per foot and determine the diagram factor for work under those conditions, which could then be applied to a different size and depth of sewer in similar conditions. The estimates arrived at are supposed to cover the items of trenching, pipelaying, backfilling, pipe and materials for making joints with cement mortar. It does not include manholes, lampholes, catchbasins or flushtanks.


Diameter of Vitrifid Pipe in Inches
Depth of Trench in Feet
Cost of Sewer in Dollars per Lineal Foot
Factor Depending on Local Conditions

SEWER-COST DIAGRAM, WITH FACTOR TO MEET VARYING LOCAL CONDITIONS

This method of making estimates has not been based on the amount of work that a man can do in a day, nor the price paid him, but has been arrived at by a study of a large number of bids on work where the size of the pipe, depth of the trench and other general conditions

were known. It is not based on work so large or of such a nature that steam shovels would be used, or work involving rock excavation or in quicksand of any considerable extent, but is based on work involving the use of vitrified pipe in diameters ranging from 6 to 20 in. and on the ordinary run of soils as we find them in the north central states. It is not supposed to give the actual cost per foot, but the amount that a contractor would bid on work of this kind for the conditions existing at that locality, and the current price for materials and labor.

Where collusion among bidders exists, or where there is a determination on the part of some bidder to get under the other fellows, the table and diagram fail.

I have found this table and diagram very convenient and useful. My office assistants learn how to use it readily. The diagram has not been previously published, and is not in the market. Neither is it copyrighted. I am giving it to the public for what it is worth, and I hope other engineers and contractors will find it as useful as I have.

Connecting Narrows Siphon to Staten Island Main

SYNOPSIS—Land connection between New York City's Catskill Aqueduct siphon under the Narrows and the Staten Island main to Silver Lake reservoir. Pipe laid in a submarine trench of maximum depth of 50 ft. excavated to land end of water-supply pipe line. Two lines of steel sheetpiling driven before excavating started. Special arrangement of piling. New connecting pipe line had to be slid as unit on carefully adjusted track on bottom of trench and fitted in siphon by divers. Special tools used to adjust trackway.

A little over a year ago a 36-in. pipe line 9,800 ft. long was constructed under the Narrows and the great ship channel of the Port of New York, to convey Catskill Aqueduct water from Brooklyn to Staten Island. The connection of the siphon, at a point outside the bulkhead line to a point on the shore above high water, to the main leading from the waterfront to Silver Lake reservoir was accomplished in a manner altogether unusual.

The depth of the siphon varies below mean water from 50 to 72 ft., the pipe being laid in a trench with 8-ft. cover. The connection between the siphon and the main on the Staten Island shore had to be laid at El. —50 for about 100 ft. of its length, the next 150 ft. rising to El. +1.4, where the land connection was made.

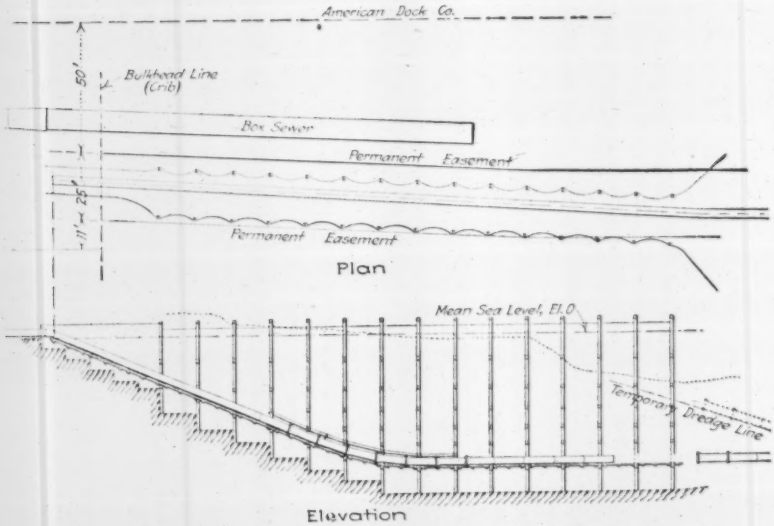


FIG. 1. PIPE LINE CONNECTING NARROWS SIPHON AND STATEN ISLAND MAIN

The profile in Fig. 1 shows the natural slope of the bank and the amount of excavation necessary in order to provide a suitable trench for the pipe. The bottom is sand overlying hardpan. Two parallel rows of Carnegie steel sheetpiling 63 ft. long were put down for a distance of about 120 ft. Thence to the shore the piling decreased in length from 60 ft. to 9 ft. The necessity for the sheeting was due to the narrow right-of-way and to the fact that the existing structures adjacent to the trench would have collapsed unless protected.

The arrangement of the piling was devised by F. T. Llewellyn, of the Carnegie Steel Co., and was put in by the Merritt-Chapman Derrick and Wrecking Co. First a series of master piles of the shape shown in Fig. 2 was put down by a derrick, using guides. The first steel master piles were placed by the derrick traveling on tracks laid on an old dock on the site, but the track arrangement was transferred to caps carried on the master piles themselves. A Hamilton steam hammer weighing about three tons and hanging from the derrick arm drove the piles.

Maintaining the Piles Vertical

It was essential that the distance between master piles should be the same throughout their entire vertical length. This was necessary in order to insure that the intermediate piling would meet properly in an arc and without distorting the interlock. Great care was taken to keep the master piles plumb and to prevent their twisting. A timber frame, built and attached to the traveling derrick, was used as a guide for the master piles, as shown in Fig. 6. The intermediate piles were driven by three derricks equipped with steam hammers. A stationary derrick worked on the shore end, a floating derrick operated at the outer end, while a traveling derrick moving along a track built on top of the master piles drove the piling between the stationary and the floating derricks. In driving the intermediate piles, a templet of the proper curve was set between the masters, and the sheetpiles were set against this templet, being arranged as shown in Fig. 7. When an entire bay had been set up,

the piles were driven. The sheetpiling was put in in August and September, 1915, and no excavating was done until this work had been completed. Excavation proceeded in much the same manner as did the pile driving. All three derricks were employed and were equipped respectively with a 2½-yd. and a 1½-yd. Williams grab bucket and a 1½-yd. Hayward orange-peel.

Transverse Bracing and Laying Pipe Track

As the excavation proceeded, transverse struts were placed between the master piles, as shown in Fig. 2. The two bottom struts were lowered double, being fastened together by long bolts carrying nuts on the upper end. As the excavation proceeded, the bottom struts continued to lower, the nuts having been set to retain the bottom strut 2 in. below grade. This allowance was for errors in measurement. It was easier to pull up on the bottom strut than it would have been to let it down. If the bottom strut had been left 2 in. above grade extra digging and troublesome adjusting would have been necessary.

From this time on until the pipe line had been laid, a force of eight divers was employed. Four divers worked in the daytime and two divers on each of the other 8-hr. watches. Their first operation was to bring the bottom struts to the correct level. This was accomplished by screwing the nuts down on the bolt, thereby raising the strut to the proper grade. The adjustment of these nuts was not an easy matter, using the type of wrenches available. The contractor's superintendent produced a very simple wrench made from a 1¼-in. iron rod, squared at the working end and turned over twice as shown in Fig. 3. Additional leverage could be obtained by slipping a piece of pipe over the handle. The track or guides down which the connecting pipe was slid was constructed as shown in Fig. 2. It was laid in sections, each two rails in length and built up with crossties.

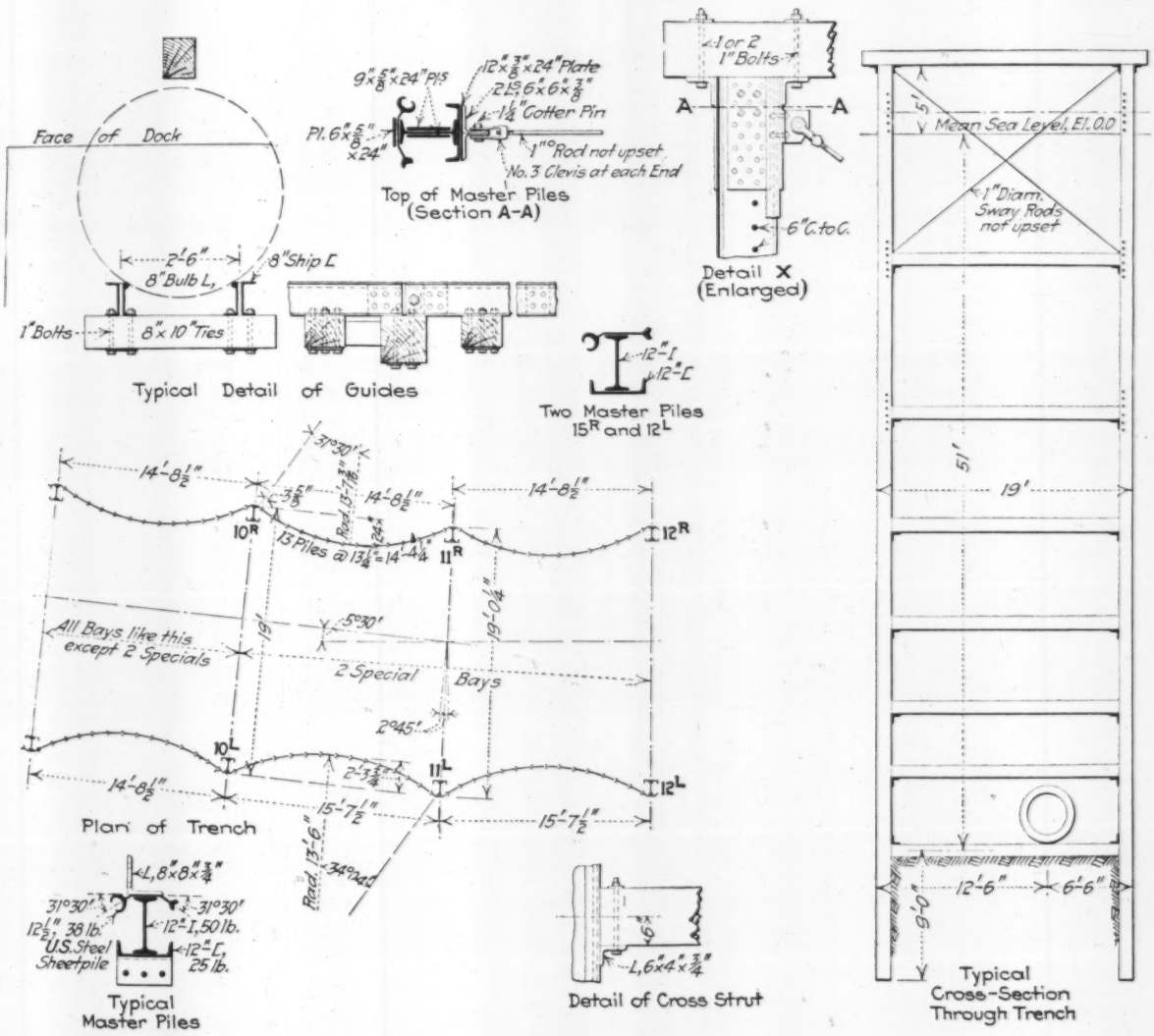

Face of Dock
Top of Master Piles (Section A-A)
1" Rod not upset
No. 3 Clevis at each End
1 or 2 1" Bolts
Detail X (Enlarged)
6" C. to C.
Typical Detail of Guides
8" Bulb L
8" Ship L
1" Bolts
8" x 10" Ties
Two Master Piles 15R and 12L
Mean Sea Level, El. 0.0
1" Diam. Sway Rods not upset
19'
Plan of Trench
All Bays like this except 2 Specials
2 Special Bays
13 Piles @ 13¼" = 14'-4¼"
Typical Master Piles
U.S. Steel Sheetpile
Detail of Cross Strut
Typical Cross-Section Through Trench

FIG. 2. DETAILS OF TRENCH CONSTRUCTION AND DESIGN OF STEEL SHEETPILING

Track-laying began at the surface and proceeded down the incline to the end of the trench. The sections were placed by divers guided by a plumb bob suspended from the overhead structure. At first an ordinary tunnel plumb bob was tried, but the motion of the diver caused it to deflect so that it was unsatisfactory. A plumb bob that gave entire satisfaction was then devised. It was made of 1¼-in. round iron 6 ft. long, pointed at the lower end and with a hole drilled in the upper. A sketch of the new plumb bob is shown in Fig. 3.

The track sections were slid down the completed track and pulled in place by the diver, who had at his disposal a

line from the traveling derrick. The outer 30 ft. of track was special, being designed and built on the job, using common railroad iron.

How Connecting Pipe Line Was Laid

In removing the skid used in laying the pipe across the harbor, the pipe had to be left on an incline with the highest point at El. —35. This end of the pipe had to be lowered to El. —50. A floating dredge was used to remove the material on either side of the pipe. The dredge worked very carefully and as close to the pipe

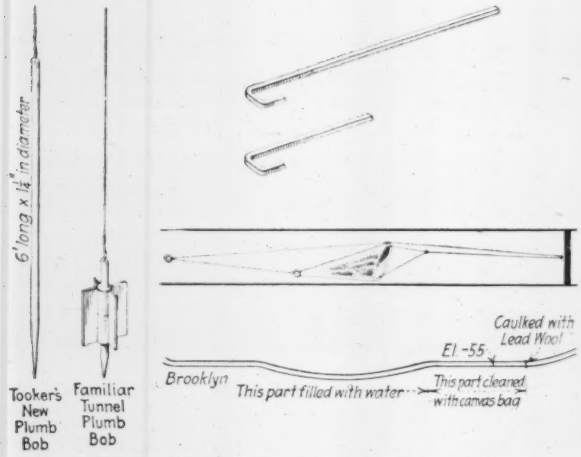

6' long x 1¼" in diameter
Tooker's New Plumb Bob
Familiar Tunnel Plumb Bob
Caulked with Lead Wool
El -55
Brooklyn
This part filled with water
This part cleaned with canvas bag

FIG. 3. SPECIAL TOOLS USED IN WORK

as possible. Divers were sent down and worked the pipe down to the required grade by the use of a water hose, washing away material underneath the pipe. It was impossible to get the exact measurement between the end of the pipe and the end of the pipe track in the sheeted trench, until the pipe was lowered to the proper grade.

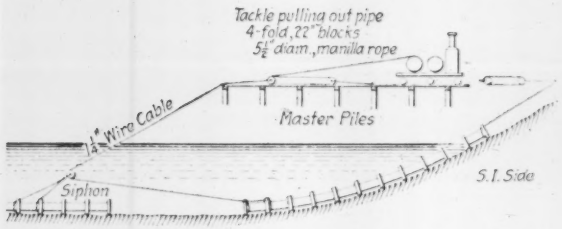


FIG. 4. HOW PIPE WAS SLID DOWN INCLINED TRACK

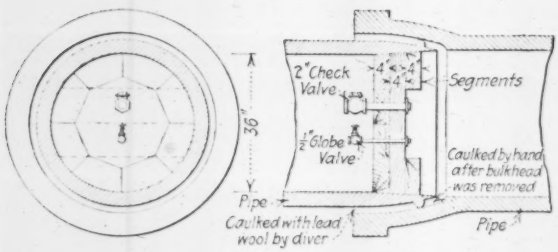


FIG. 5. TIMBER BULKHEAD IN FORWARD END OF PIPE

The section of connecting pipe was hauled down the incline, being kept from running away by the tackle, shown in Fig. 4. Into the spigot end of the leading pipe a timber bulkhead had been built, as shown in Fig. 5. The bulkhead was penetrated by two short lengths of pipe fitted on the inside with a 2-in. check and a 1½-in. globe.

As the connecting line descended the incline and approached the finished siphon, new pipe lengths were fitted on its exposed end and calked. Finally, the bulkheaded end of the line was steered into the bell end of the deep-water line. A diver calked the exterior portion of the joint with lead wool.

Compressed air was directed into the connecting line, passing through the 2-in. check valve and driving the water in the siphon toward the Brooklyn shore. When the water had been driven back as far as possible with the air pressure available, the air was shut off and then

FIG. 6. GUIDE FRAMES USED TO KEEP MASTER PILES VERTICAL

allowed to escape from the siphon by way of the globe valve. The water remaining in the siphon now returned a certain distance until a uniform level was established at about El. —55, leaving a certain length of the siphon dry.

The timber bulkhead was now removed from the connecting pipe and workmen entered the siphon. The latter was found to contain considerable mud in the unwatered length, and this was cleaned out by means of a canvas bag (Fig. 3) fitted with a hoop at one end and used like a dragline. Workmen now calked with lead wool the inner portion of the joint between the connecting pipe and the older submarine line.

The connection having been made to the siphon and the joints being found tight, backfilling was begun. As this work proceeded the transverse struts were removed. The

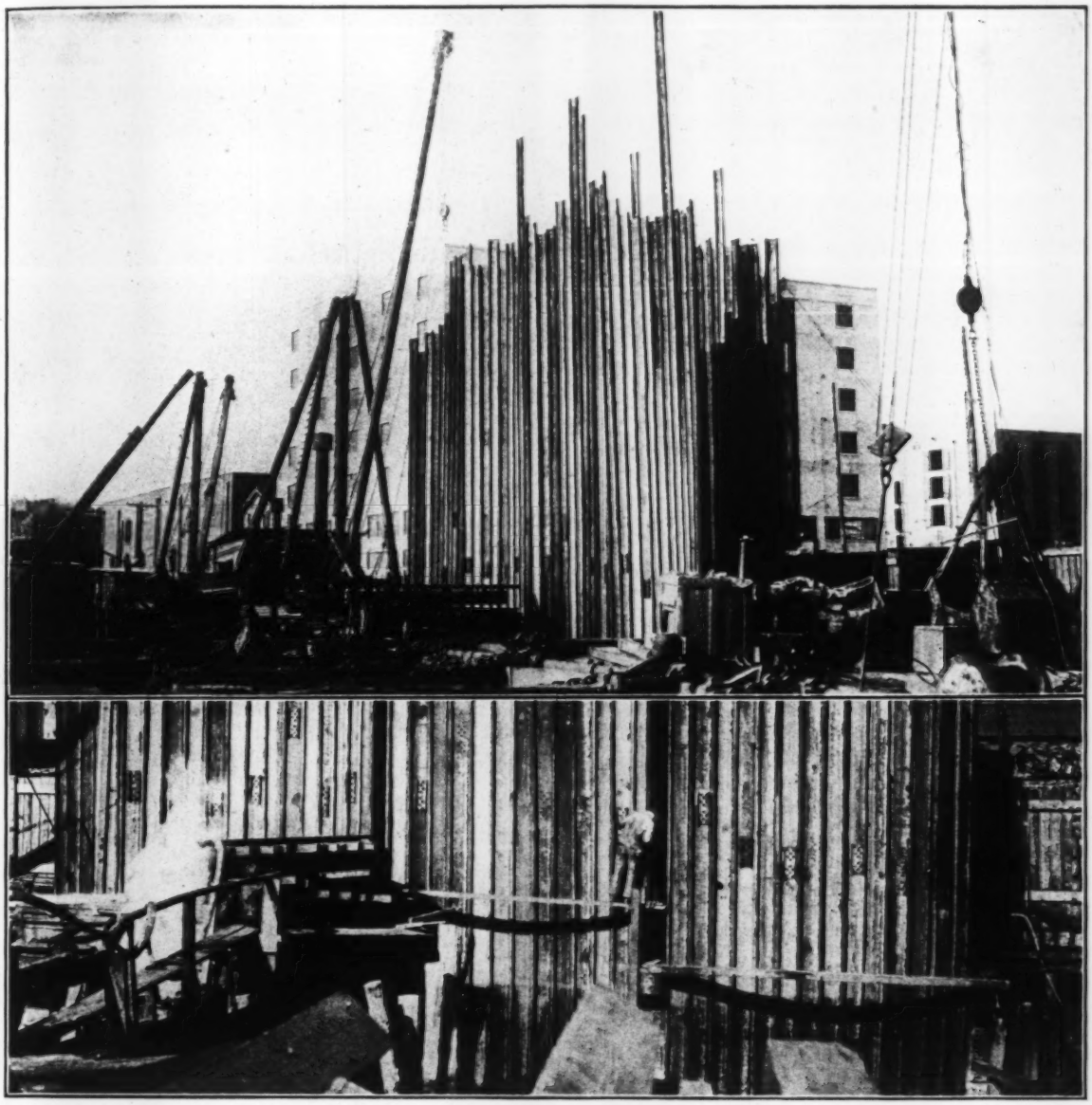


FIG. 7. TWO VIEWS OF SHEETPILING SET UP FOR DRIVING

Upper—Set of 13 intermediate piles assembled. Fixed derrick at extreme left, traveling derrick alongside. Lower—The man in the view is putting on splice plates

same buckets were used to backfill as had been employed in excavating. The fill consisted of Copenhagen Channel ballast sand, Cow Bay sand from Long Island, and ballast sand from England. The ballast was unloaded from ships onto flat scows, which were towed to the trench and unloaded by the buckets.

The excavation and the placing of the transverse struts occupied the time from September, 1915, to January, 1916. Laying the track and pulling the connecting pipe into place was finished by the middle of April, while the backfilling was practically complete June 1. Since then the contractor has been engaged in recovering the sheet-piles.

The work was done under the supervision of the Board of Water Supply, of which J. Waldo Smith is Chief Engineer; Alfred D. Flinn, Deputy Chief Engineer; Walter E. Spear, Department Engineer, and John P. Hogan, Division Engineer. The contractor is the Merritt-Chapman Derrick and Wrecking Co., 18 Battery Place, New York City, of which Ralph Chapman is Mechanical Engineer and I. M. Tooker is Superintendent on the job.

Iron Ore Mined in the United States in 1915 reached a total of 55,526,490 gross tons, the greatest output made in any year except 1910 and 1913. Shipments (valued at $101,288,984) were a little less than the quantity mined. The latter was an increase of 14,000,000 tons over the output in 1914. The increases in quantity and in value of iron ore shipped amounted to about 40 and 41% respectively. The average value per ton in 1915 was $1.83, compared with $1.81 in 1914. These figures, which are just made public by the United States Geological Survey, were prepared by E. F. Burchard, who states that the production of iron ore from the Lake Superior district, alone, in 1916 will possibly be 60,000,000 tons, and that there will probably be an increase in price of 70 to 75c. a ton for this ore.

Concrete Bridge Completed from Suspended Forms

By F. R. Goodman*

A flood that washed out the centering of a reinforced-concrete bridge under construction over the Little Colorado River, four miles east of Holbrook, Ariz., last winter, not only demonstrated the stability of the structure at an age before it normally would have been self-supporting, but forced the engineers to resort to unconventional methods in the erection of the incompleted side brackets.

The arch is a Luten design reinforced-concrete highway structure of 174-ft. span and 20 ft. 9 in. rise. It consists of a single barrel arch rib 8 ft. wide with spandrel walls filled between with earth. The full width of the roadway (16 ft.) has been gained by reinforced-concrete slabs resting on cantilever brackets, spaced 7 ft. on centers. In line with these brackets a reinforced-concrete tie-beam connects the tops of the two spandrel walls.

The construction work was begun by the Arizona State Highway Department, using day labor, on Oct. 29, 1915. The centering is founded on bents of 10-in. piles, five of the piles in each bent being centered under the main arch rib and one under each bracket. On these piles were carried fan-shaped struts which supported the lagging and which were made up of three 2x8's arranged T-fashion and wired together after the well-known Luten patent. The wires were to be cut to allow the arch to be sprung.

Owing to the quantity of concrete in the ring (260 cu.yd.) and the small capacity of the mixing plant, it was decided to cut the ring into transverse sections somewhat narrower than the main arch rib and to make three pourings instead of one continuous run for the entire amount.

*Division Engineer, Arizona State Highway Department, Coconino County, Parks, Ariz.

A key section was poured first, two spring sections second and the two intermediate sections last. The third sections were poured just as soon as the concrete in the second section had set sufficiently to allow the intermediate forms to be removed. This work was started along toward the end

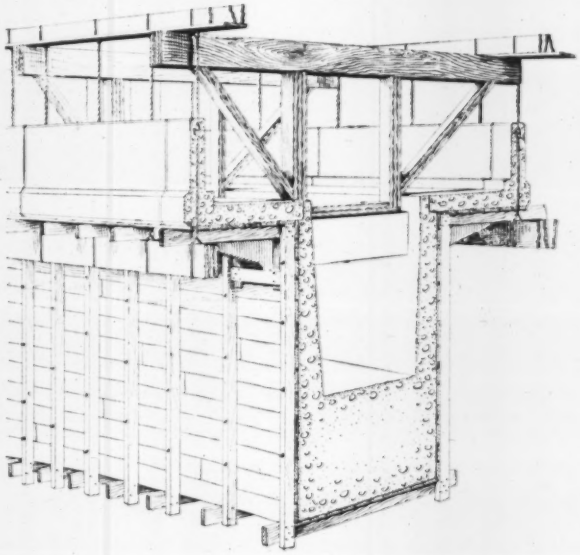
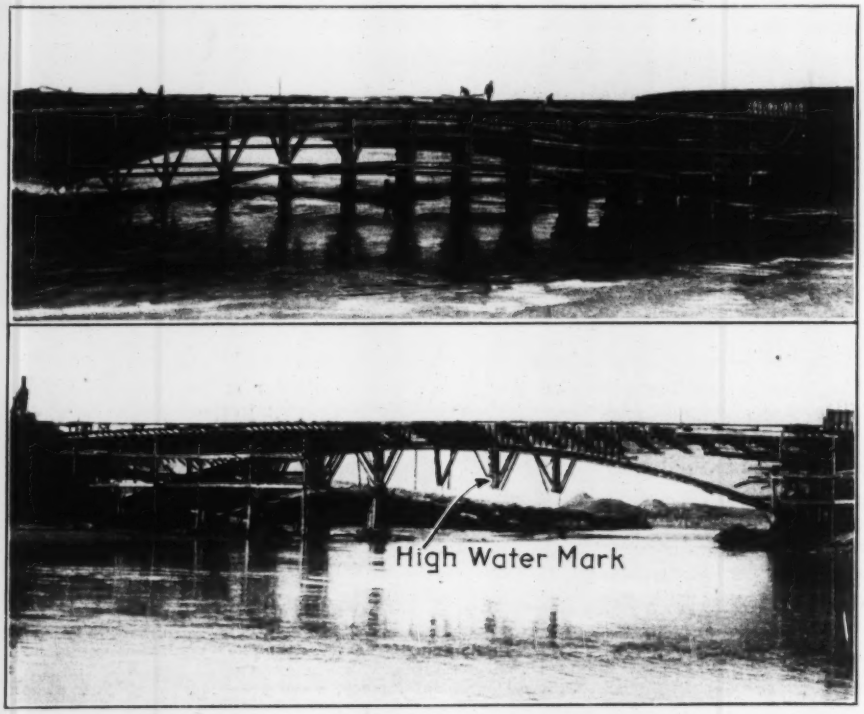


FIG. 3. METHOD OF SUSPENDING FORMS FOR COMPLETING BRIDGE

of December. At no time during the pouring of the concrete ring was the thermometer above 40° F., the temperature at 7 a.m., noon and 6 p.m. each day being 16°, 38° and 26° at 7 a.m.; 20°, 40° and 26° at noon; 12°, 40° and 30° at 6 p.m. respectively. Neither material nor water was heated. However, no frozen concrete was allowed to go into the forms. The first pouring did not extend to the full 8-ft. width of the arch rib but only as far as the inside edge of the spandrel wall, and it was the intention to complete the bridge in another operation by pouring the remainder of the rib and its superposed floor and extending brackets on forms resting on the falsework. In pursuance of this scheme, after the arch ring had set sufficiently to remove the outside form, the pouring of one spandrel wall and floor brackets was begun and continued until the entire length of the span was completed. Then the other wall was completed in like manner. The concrete was deposited alternately on opposite ends of the span, beginning at the abutments, so as to keep a uniform loading on the falsework. On Jan. 19, 1916, the fourteenth day after the second wall was poured, the arch rib was completed, the



FIGS. 1 AND 2. FLOOD WASHES OUT FALSEWORK AND CENTERING OF UNFINISHED BRIDGE

spandrel walls were completed, and all of the brackets and tie-beams were in place. On that day a sudden flood in the river took out 8 of the 13 bents of falsework (see Figs. 1 and 2). The Little Colorado River at this point has a fall of approximately 11 ft. per mi. and carries a large amount of driftwood at all high-water stages, but the amount during this flood was excessive. The débris was piled up to within 4 ft. of the crown of the arch. A cottonwood tree about 30 in. in diameter at the trunk stuck broadside, causing the final failure. Notwithstanding the fact that the oldest concrete was only about a month old and had been placed in practically freezing weather, the arch stood intact with hardly any deflection.

With the supporting falsework gone, the problem of constructing the floor and the handrail remained. It was impracticable to drive new centering under the brackets, which were considered not to be of sufficient age to warrant their being used as the basis of forms to carry the load to the new concrete, particularly on account of the cold weather during which they were poured. It was decided, then, to suspend the forms for the floor from the completed work. The method of doing this is shown in perspective in Fig. 3.

Trussed frames were erected on the completed tie-beams and arch rib and from their outside extremities were hung longitudinal stringers that in turn carried joists. These joists at the outside rested on the stringers and at the inside were fastened to the studding and lagging of the spandrel-wall forms, which had been left in place wired through and thus were quite capable of holding loads. On the floor thus built the cantilever slabs were laid.

The labor cost of constructing this suspended falsework was $27, the material used being form lumber taken from the spandrel walls and the arch ring. After a delay of 30 days from the pouring of the last spandrel wall the floor slab and handrail were commenced and continued until completion.

The State Engineer of Arizona is Lamar Cobb. T. F. Nichols is Bridge Engineer, and the writer was in charge of the construction work described.

An Attempt To Standardize Valuation Terms

The Valuation Committee of the American Electric Railway Association, in its report at the recent Atlantic City convention, proposed a list of 21 words (drawn up by C. G. Young, Consulting Engineer, New York City) which it was thought would cover all the terms which it would be necessary to employ in discussions of valuation matters. This list, which is reprinted below, would replace the longer list of 300 odd words whose use has been noted.

PROPOSED DEFINITIONS OF WORDS USED IN VALUATION WORK

1. Public utility:

A business operated under a public grant and performing a stipulated public service for compensation.

2. Franchise:

The grant by a public authority of the necessary rights to do a specific business, and including the use and occupancy of some portion of the public lands.

3. Property:

That which is owned by a company or individual by virtue of legal rights through possession, title or lease.

4. Ownership:

The legal title to, or possession of, property.

5. Value:

Worth (see definition of worth).

6. Valuation:

Act of determining worth.

7. Worth:

Exchangeable value (Webster).

Including every item of value entering into and affecting the value of a property, tangible and intangible, physical and nonphysical, also every kind of value from whatsoever sources derived, or by whatsoever means or cause affected, favorable or unfavorable, and as of the present time and including full consideration of past performance and future probability.

Notes—(a) It is seen that worth (value) is not constant, but is affected and increased or diminished from time to time by a number of conditions and circumstances.

(b) That worth (value) is dependent, among other things, on earnings and therefore on rates and tariffs charged for the services rendered.

(c) That worth (valuation) thus defined cannot be made the basis of the amount on which a reasonable return is to be allowed by courts.

(d) That an appraisement only shows a part of the worth of a property.

(e) The ward "value" should not be used except when worth is intended.

8. Investment:

The total amount of cash, or its equivalent, that has gone into the creation and development of a property, from whatsoever source derived, including new money used for obsolescence and development.

9. Capital:

The total number of shares of a company, preferred, ordinary or otherwise.

Notes—When these shares have a stipulated par or face amount, the total aggregate sum expresses the capital of the company.

(a) The capital face amount of a company may be more or less than the investment, and is divided into more or less shares for convenience of increasing or decreasing the fractional, partnership divisions.

(b) Capital shares have no fixed relation to the investment.

10. Sinking fund:

An accumulative fund, set aside from earnings from year to year, out of which moneys are paid for amortization of investment.

11. Amortization:

The repayment from time to time of part of the investment by means of a sinking fund.

12. Obsolescence:

The state of becoming obsolete (Webster). The replacement of property before it has reached its full period of usefulness due to,

(a) The advance of or changes in the art or process in practice, or

(b) Public legislation or demand.

13. Depreciation:

Is the lessening in worth of physical property due to use or other causes.

14. Appreciation:

The increased worth of any part of a property not due to additions to investment.

15. Maintenance:

The cost of repairs and renewals for the proper up-keep of a property. Maintenance is of two kinds,

Ordinary and deferred:

(a) Ordinary Maintenance—Those repairs which are made each year as needed.

(b) Deferred Maintenance—Those repairs which cannot economically be made each year but which are made at frequent intervals.

Note—Maintenance is a part of the cost of operation.

16. Rate of return:

The percentage rate of return earned and paid on the total investment.

17. Tariff rates:

The charges made and collected for services rendered.

Note—The theory being that the rates should be sufficient to cover all operating expenses, repairs and maintenance, depreciation, obsolescence, rewards of management, legal expenses, accidents, insurance, taxes, and general overhead and miscellaneous expenses; also a stipulated amount for amortization and sinking fund, interest on bonds and other forms of indebtedness, and dividends to cover the rate of return allowable on the total investment.

18. Inventory:

The count or measure of all separate items comprised in a property, including physical property as well as certificates or other evidences of ownership.

19. Appraisal:

A complete study of a property showing the cost to reproduce new, based on inventory, and also showing depreciation.

Note—An appraisal is but one of the factors to be considered in determining worth.

20. Intangibles:

Such items of value of a non-physical nature as such are not represented in the existent property but reasonably constitute a definite part of the assets of a corporate enterprise,

such as contractual rights (franchise value), expenses incurred in development of plant or business, damages resulting from condemnation proceedings, etc., etc.

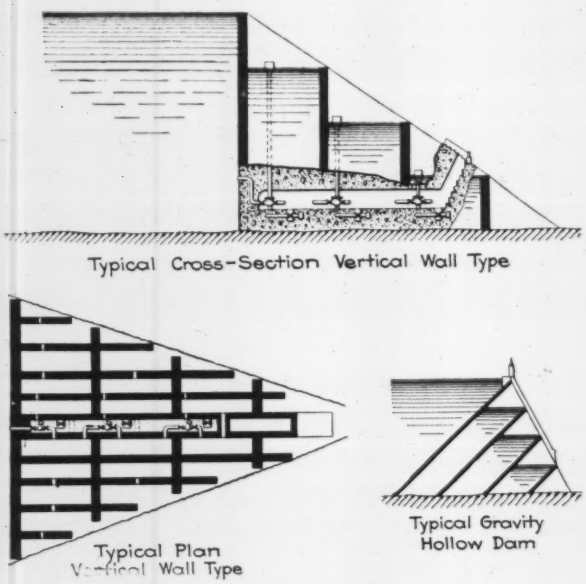
21. Overhead costs:

Such general and miscellaneous expenditures, forming a portion of the cost of a property, which, because of their nature, are not or cannot be included in the unit prices.

New Hollow Concrete Dam with Subdivided Water Pressure

Just before the entry of Italy into the European War full plans had been made for the construction at Genoa of a 157-ft. high reinforced-concrete hollow dam of novel type. The construction was held up by the war, but it is stated that it will start as soon as conditions admit. An American patent (No. 1,167,116) of the dam type has been secured by the inventor, Peter Rutenberg, 675 East 170th St., New York City.

The details of a dam of this type are shown in the accompanying drawing, which illustrates the principle, but not necessarily its structural variations. As shown there, the patented design consists of a development of the ordinary hollow reinforced-concrete dam section, so that instead of having one deck there are a number of



RUTENBERG HOLLOW CONCRETE DAM

parallel decks of decreasing height extending back from the reservoir face to the rear of the dam, dividing the structure into a series of intercommunicable water-filled wells formed by the decks and the buttresses.

The essential element of novelty is that the decks are subjected not to the full head of water retained, but to the difference in head between the water levels on the two sides of each deck. These water levels are maintained at proper elevation by automatic valves placed in the buttresses and intercommunicating between the upstream and downstream wells. Openings in the buttresses assure the distribution of the water along the dam.

The advantages claimed for this type of dam are: (1) A smaller volume of concrete than for the ordinary reinforced-concrete dam. This is due to the fact that while the multiple decks require more concrete than the one deck of an ordinary reinforced-concrete dam (even though each is designed to resist only the increment of head), the buttresses can be made sufficiently lighter to make up the excess in the decks on account of the more thorough bracing insured by the decks. (2) Greater safety, because no one part of the dam is subjected to anything but a small proportion of the total head of water. (3) Less danger of percolation under the dam, owing to this same subdivision of the head. (4) Provision for a safe disposal of flood waters by the waterfall effect, so termed.

The inventor claims that, even should the valves not work, there would be no danger of the lower wells emptying out and leaving the full head of the reservoir to be taken by the upper deck, with consequent failure of that deck and progressive failure of the rest of the dam, because before this happens the lower part of this main deck would break under a head much greater than that for which it was designed, thereby allowing an opening for the water to go into the next lower well, and that this process would continue down through the well and automatically relieve the pressure on any one deck. He does not, however, anticipate any trouble in maintaining the valves in continual working order.

Asphaltic-Concrete Paving at Oak Park, Ill.

A considerable amount of asphaltic-concrete paving is being done at Oak Park, Ill., which is largely a residential suburb of Chicago, with heavy team traffic only on the main streets. There is, however, heavy local and through automobile traffic. The work includes both the construction of new streets and the improvement and resurfacing of old macadam. All work is done under special assessments, and the contractors give a five-year guarantee.

This kind of paving has been used for about five years, and for the present work a special mixture was devised to meet the traffic conditions. It is intended to combine low first cost with permanence, thus reducing maintenance expenses. This was done under the direction of W. F. Sargent, Commissioner of Public Works and Chief Engineer for the Board of Local Improvements. Dudley C. Myers is engineer in charge of construction, and H. W. Skidmore is chief inspector.

The contractors take the entire work, but generally sublet the concrete curb and gutter to men who make this a specialty. The engineers exercise close inspection of the work and keep account of the cement that goes into the concrete in order to insure that a sufficient proportion is used. The width of paved street is usually 30 ft., crowned to 3 in. above top of curb.

On the work done in 1915, the cost of 2-in. asphaltic-concrete paving on 6-in. concrete base was $1.35 per sq. ft. ($4.13 per front foot). Where 2-in. asphaltic concrete was laid directly on old macadam, the cost was 94.7c. per sq.ft. ($2.93 per front foot).

Asphaltic-Concrete Surfacing

The Topeka mixture used at first did not prove entirely satisfactory, and the conditions were investigated by Lester Kirschbraun, testing engineer, of Chicago, who made laboratory tests with various aggregates. The coarse aggregate of the mixture adopted is of the same size as that in the Topeka mixture but in larger proportion, while the mortar or asphaltic cement is practically the same as for a sheet-asphalt mixture.

The mix (by weight) is approximately 40 to 55% crushed limestone, 36% sand, 7% stone dust and 7%

bitumen, or asphaltic cement. All the stone must pass a ½-in. sieve, with not more than 10% retained on a ¼-in. sieve. The stone-dust filler must be of such fineness that at least 65% will pass a 200-mesh sieve. Where team traffic is carried, granite or crushed gravel is used in place of limestone.

The asphaltic cement is required to meet the sheet-asphalt specifications of the Society for the Standardization of Paving Specifications (now the American Society for Municipal Improvements). The Trinidad asphalt is used principally; also some Mexican (Aztec) asphalt. A common mixture is 75% Trinidad asphalt and 25% Standard road oil. The material must be heated to 300 or 325° F. and then combined with the hot sand, stone and filler (at about 375° F.) in a mixer having revolving blades. This mixer must be so arranged as to retain the heat, but must not expose the material to the direct action of the fire.

The asphaltic concrete is hauled to the work in covered wagons, and is required to have a temperature of not less than 250° F. when deposited. For the work this season the Commonwealth Improvement Co., of Chicago, has used a Cummer one-car railway plant installed on a siding, so that the haul is short (about 1½ mi. maximum). Other contractors have prepared the material at stationary plants in Chicago, delivering it in large motor trucks. Even with a haul of 15 mi. the material would be at nearly 300° F. when deposited.

The asphaltic concrete is deposited directly upon the concrete base, and spread with forks and iron rakes, being leveled in such a way as to give a finished thickness of 2 in. Heavy rolling of the hot mixture is one of the special features of the work. This is done with steam rollers of the tandem type, weighing 8, 10 and 15 tons. A three-wheel 10-ton roller is also to be tried. This use of heavy rollers gives a close initial compression, and the mass is of such consistency and so well anchored by the rough surface of the concrete base that it does not mash out or flow away under the heavy roller.

After the first rolling, the material is allowed to cool, as if the rolling is done continuously cracks are likely to develop. The rolling is then resumed, about five hours per 1,000 sq.ft. of surface being required. Lighter tandem rollers are used to finish or iron out the surface.

The asphaltic concrete is laid in one operation, and finished with a brushed coat of dry portland cement. No seal coat is applied and no binder course is used, the concrete base being given a rough surface (as noted below) to effect a mechanical bond. Nor are sand or screenings spread upon the finished surface, as such a coating is crushed under traffic and blown away without serving any useful purpose. In fact it is objectionable on account of the dust thus produced. The work is done continuously as far as possible. Where a joint must be made, the surface of the cold material is dressed to a feather-edge and painted with asphaltic cement before the new hot material is laid.

Concrete Base and Curb

The subgrade is dressed to conform to the crowning of the roadway, and is well compacted with a heavy roller. Upon this is laid the 6-in. concrete base, with its top 2 in. below the surface of the finished pavement. This is a 1:3:6 mix, using ½- to 2-in. crushed limestone for the coarse aggregate. Fine limestone screenings are used in place of sand, as they make a thicker or more creamy slush. A man with a broom sweeps the excess slush ahead and by skillful use of the broom gives a rough surface to the concrete, with stones projecting ¼ to 1½ in. above the normal surface. These projections form an effective bond, or anchor, for the bituminous top course, so that the binder course is dispensed with, as noted before.

The specifications require the mixer to be run at 14 r.p.m., and each batch revolved for a period of one minute. They also require the use of a spout or boom-and-bucket for distribution, depositing the concrete at a distance of about 14 ft. from the mixer. The angle of the chute is generally 20°.

The concreting gangs average 27 men, with a 1-yd. mixer. With a 50-man gang as much as 2,400 sq.yd. of 6-in. concrete base has been laid in a 10-hr. day. The materials are dumped in piles by motor trucks or dump wagons, and are delivered to the mixer in wheelbarrows. The inspector keeps careful record of the amount of cement per yard of concrete.

The ends of the pavements (where they connect with unpaved streets) and the sides in streets having car tracks (unpaved) are protected by headers of 3x12-in. oak planks. The transverse headers have the upper surface dressed to the crown of the roadway. They are secured by 6-in. cedar posts 3 ft. long, and backed with a layer of crushed stone. This prevents the cutting and disintegration of the asphaltic concrete by wheels passing on and off the paving. In some cases a 4-in. concrete header is used.

The combined curb and gutter is of concrete on a cinder bed, and is laid in 6-ft. lengths. It has a 7-in. curb, the face of which varies in height from 5 in. at the summits to 10 in. at the catchbasin inlets; the 6-in. gutter flag is 18 in. wide. The mix is 1:2:4, using fine granite screenings and crushed granite of ¼- to 1½-in. size. A 1:1 mortar finish (made with the fine granite) is applied, ½ in. thick on the top and face of the curb and 1 in. thick on the gutter. The surface of the gutter has an upward slope of ⅔ in. per ft. to conform to the crowning of the roadway. A ½-in. asphalt-filled expansion joint is made at each summit between the catchbasins.

Miscellaneous Features of the Paving

Where old macadam paving is over 5 in. thick, it is dressed to subgrade and upon it is laid a 2-in. course of new asphaltic-concrete wearing surface.

On streets that are to be repaved, the sewers and house connections are tested with rods, and the connections are opened up at the curb line for inspection. Any necessary repairs are then made. The water and gas mains, electric conduits, etc., are also overhauled before the new work is started. All old iron catchbasins are taken out and replaced with new brick catchbasins; and new brick manholes are built where necessary. The new curb inlets to catchbasins have not only the horizontal grating but also a vertical opening (without grating) in the face of the curb, so that there may be no obstruction by leaves or débris during storms. The horizontal grating (in the gutter flag) is locked down upon its frame, so that it cannot become loose or noisy. All new manholes also are fitted with the Dougherty nonrattling self-locking covers.

Some of the grading for new streets has been done with Maney four-wheel scrapers, a 10-ton steam roller being used to haul them when loading. Difficulty has been

found in cutting to exact grade in this way, and to avoid cutting too deep the machines have cut a little above normal, the surface being then trimmed to exact grade by hand. The haul is short, most of the excess excavated material (not required for parkways, etc.) being deposited as fill on vacant lots.

Concrete paving is being used for the alleys, which are generally 16 ft. wide. The concrete is 6 in. thick on a 6-in. bed of cinders. Sometimes the paving is crowned or convex, but it is dished or concave wherever sufficient fall can be secured to carry the water to the adjoining streets. Expansion joints are placed 33 ft. apart.

Organization of the Baltimore Water Department*

The accompanying chart shows the organization of the Baltimore Water Department. There are five divisions, each responsible for work of a specific character, the head of each division reporting directly to the water engineer, Walter E. Lee.

The new Construction and Maintenance Division, under a principal assistant engineer, represents the consolidation of the former engineering and construction divisions and provides for close engineering supervision of all construction, maintenance and testing work, the previous lack of which resulted in slow and costly construction.

Reporting to the principal assistant engineer, as shown on the chart, are (1) an assistant engineer in charge of construction, who supervises all general extension work of the underground system as well as work in streets in advance of improved paving; (2) an assistant engineer in charge of maintenance, who supervises the installation of house, meter and fire services, and the repair and maintenance of mains and appurtenances (which have been transferred to him by the assistant engineer in charge of construction); (3) a pitometer engineer who is in charge of pitometer tests for the detection and elimination of underground leaks in both mains and house services, and who also has charge of daily house-to-house inspection.

The pitometer engineer also has charge of the installation of curb cocks and boxes, and the testing of mains by hydraulic pressure to double their working pressure before releasing streets to the city paving department for laying new paving.

A designing engineer reporting directly to the principal assistant engineer is detailed to have entire charge of power-plant design and equipment, and special work problems.

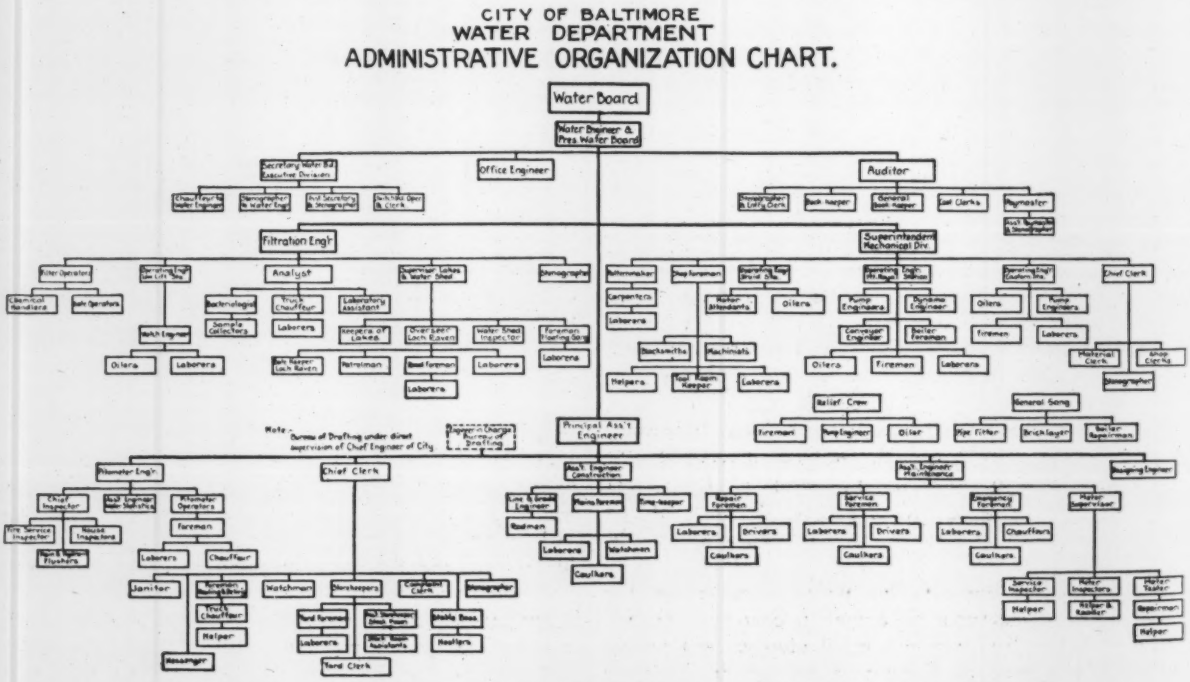
A chief clerk handles all the office detail, which prior to the reorganization of the Water Department fell directly upon the principal assistant engineer, with the result that instead of five subordinate heads, each in charge of a specific group, reporting to him as at present, there were as many as 24 minor employees reporting directly to him, which left very little time for his attention to engineering matters.

The Mechanical Division reporting to its superintendent embraces the operation and maintenance of the Mount Royal pumping station, which pumps to the western part of the city, the Eastern pumping station, which pumps to the northeastern section of the city and the Druid electric pumping station, which supplies West Arlington, Walbrook, Forest Park and Guilford, an operating engineer being in charge of each pumping station and reporting directly to the superintendent.

A shop foreman is in charge of the machine shop, in which general machine repairs are made and overhead expense balanced by the manufacture of hydrants and valves. He also has charge of the machine shop, toolroom and blacksmith shop.

A chief clerk is in charge of the office and general work of the Mechanical Division, supervising all shop orders,

*From the Baltimore (official) "Municipal Journal."



ORGANIZATION CHART OF THE WATER DEPARTMENT OF THE CITY OF BALTIMORE, MD.

and keeping records of manufacturing costs and stock and material on hand. Here, as in the Construction and Maintenance Division, the chief purpose was to relieve the division head from being crowded with too great detail, so that attention could be given to more efficient plant operation.

A relief crew, consisting of a pump engineer, fireman and oiler, "floats" from station to station, thereby keeping up the continuous 24-hr. operation on a relief schedule. A general gang, composed of a pipe-fitter, bricklayer and boiler repairman, also "floats" from one pumping station to another, making repairs to boiler settings, furnace walls, tubes, stacks, piping, etc.

A Filtration Division was organized as a new operating unit following the completion of the new rapid sand-filter plant at Lake Montebello. The scope of the work was enlarged to include the entire watershed, consisting of 308 sq.mi., the storage and pounding reservoir at Loch Raven, reserve storage and distributing reservoirs throughout the city, as well as the operation of the Montebello filters proper. This placed the entire water-supply up to the point of distribution directly under the supervision of a trained engineer who could correlate rainfall, stream flow, turbidity and pressure head with the treatment of the water as it passes from the mixing and coagulating basins prior to its being passed on its way through the sand filters.

The operating engineers, one on each 8-hr. shift, are in direct charge of the low-lift pumping station, which takes the water from the 12-ft. masonry tunnel under Loch Raven and pumps it to the filtration plant. Filter operators, one on each 8-hr. shift, are in charge of the filter galleries and the washing of the sand beds, and report directly to the filtration engineer.

A chemist is in direct charge of the laboratory in which the physical and bacteriological qualities of the water are determined, and he also has charge of the truck crew which hauls the chemicals used at the plant.

A supervisor of lakes and watershed, reporting to the filtration engineer, has direct supervision of the patrol (or policing) and maintenance of the watershed, and the upkeep and care of all reservoir properties throughout the city.

The Executive Division, in charge of the secretary of the Water Board, handles and distributes the mail of the entire department, transacts its general public business and issues Water Department permits.

The Auditing Division, reporting to the auditor, handles all the billing of work included on order, the issuance of specifications and the execution of contracts, the compilation and analysis of cost data for a summary statement to the water engineer, and gives a close checking to all requisitions issued by the five divisions.

In order to eliminate lost motion and obtain more economical operation, there are held biweekly discussions by Water Engineer Lee with the five division heads. These meetings tie together the work of the Water Department as a whole and coördinate the work of one division with another to the general efficiency of the department.

The reorganization of the Water Department has resulted in an enormous reduction in overhead expense, accompanied by the elimination of obsolete and useless positions, and the consolidation of work under assistant engineers and chief clerks.

American Trenching Machines in the European War

A feature of the engineering activities in the great war is the use of American trench-excavating machines to dig the long lines of trenches required for the protection of defensive and reserve positions behind the actual front. The speed and steady work of such machines, and the fact that their use would avoid the necessity of employing large numbers of fighting men for such work, led to their consideration by the British, French and Russian military authorities early in the war. At the recent meeting of the Iowa and Illinois sections of the American Water-Works Association, at Davenport, Iowa, a paper on this use of trenching machines was read by A. E. Miller, of Des Moines, who was in charge of the design and superintended the erection and testing of the American machines in Europe, besides training the men to operate them.

Many special conditions had to be met. One of the first difficulties was in regard to the line of the trench. The machines are adapted for cutting on long straight lines, but for military purposes the trenches were to be in the form of an irregular line, each stretch consisting of three sides of a rectangle, thus protecting the men in the trench from enfilading fire. As the ordinary machine could not turn right angles or turn in 12-ft. lengths, a sawtooth line of trench was adopted, giving room for the machines to swing in turning the angles. Each stretch was 50 ft. long.

The first machine was shipped to England and then to France, where the actual tests were commenced. Here the country was rough, and the lines of trenches lay behind stone walls, along sidehill ground and through woods. For successful work under such conditions special designs of machines would have been required. On the Russian front, however, the country was level and open, and more use was made of long straight stretches of trench. As a result of the tests 22 gasoline trenching machines were ordered. These cut trenches 3½ ft. wide and as deep as 6 ft. They were shipped from Seattle to Vladivostok and thence were forwarded to Moscow, where an assembling and training station was established in charge of Mr. Miller.

The first of these machines was sent to the front in October, 1915, but as the ground was getting frozen, the winter was spent in training the soldiers assigned to the service, there being two enginemen and two helpers for each machine, to provide against accidents. The work of the machines was done at 30 to 250 mi. from the fighting line. Special troubles encountered were drainage in some cases and the caving of the sides in other cases.

Numerous suggestions were made by the engineer officers for a trenching machine that could be used for sapping and trenching at the actual front. This service would require a machine that would travel on the bottom of the trench (instead of on the surface) and be entirely below ground. Such a machine was designed by Mr. Miller; but it is thought that this was not built, although several experimental trenching machines were built in England under the direction of the military engineers. A special difficulty in the design of such machinery is the necessity for combining both strength and lightness, so that the machines will be sufficiently reliable and at the same time readily portable.

In assembling the machines the work progressed very slowly, as compared with American practice, and it was difficult to get men to adopt methods new to them, while men in charge hesitated to accept responsibility without referring the matter to the next man higher up. Among those in higher authority Mr. Miller found a very favorable opinion of American work and methods and a strong desire for closer commercial relations in the future.

Effect of Seasonal Rainfall on Annual Runoff

By James P. Wells*

It is not an uncommon statement that the amount of annual runoff will be equal to a certain percentage of the annual precipitation. However, from a careful study of the relation between rainfall and runoff it is evident that even on a particular stream the percentage of the rainfall which runs off is different every year. The fact is that on a given stream the seasonal distribution of the rainfall has more to do with the amount of runoff than anything else.

The late G. W. Rafter, for the purpose of a clearer understanding of the relations between rainfall and runoff on New York streams, has taken a year as beginning with December instead of January. This year Mr. Rafter called the water year and divided it into three periods: December to May, he designated as the storage period; June to August, growing period; September to November, replenishing period.

The Flood, Growing and Replenishing Periods

The writer calls January to May, the flood period, June to September, the growing period, and October to December, the replenishing period. Almost always the ground is saturated by the first of January and during the next five months by far the greater portion of the precipitation runs off. The following four months comprise the main part of the growing season, during which vegetation absorbs most of the rainfall and the supply of groundwater is also drawn upon. The rains of the next three months, which comprise the replenishing period, are for the greater part absorbed by the ground to replenish the depleted groundwater supply. These are the average conditions but do not hold true every year. In some years, the ground becomes saturated by the end of November and in others the groundwater supply is low until February of the next year or even later.

It can easily be seen that the runoff will be affected by the distribution of rainfall as to seasons.

Rainfall and Runoff on the Chemung River Basin

The effect on runoff of the distribution of the precipitation throughout the year is illustrated by the records for the Chemung River watershed for the years from 1907 to 1912. The Chemung River drains the hilly country in the southern-central part of New York state. It is described in Water Supply and Irrigation Paper No. 109 as follows:

> The topographic features of the drainage basin are, as a rule, bold and broad, the hills rise within a short distance of the stream several hundred feet on either side, and the upland plateau is to a large extent wooded, with impervious soil, no lake storage and few marsh areas. Tributaries are ramifying and uniformly distributed though not numerous, and dry gullies or flood channels are common.

*Consulting Engineer, Rochester, N. Y.

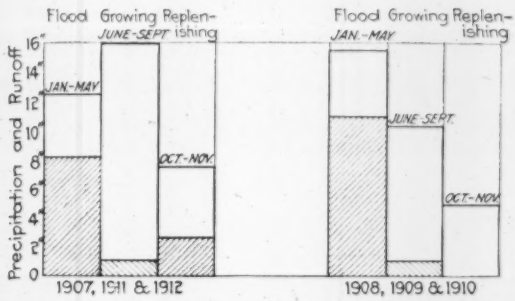
CHEMUNG RIVER RAINFALL, RUNOFF AND EVAPORATION DATA; INCHES IN EACH PERIOD

	Flood Period			Growing Period			Replenishing Period		
	Rainfall	Runoff	Evaporation	Rainfall	Runoff	Evaporation	Rainfall	Runoff	Evaporation
1907	11.27	7.62	3.65	13.40	1.10	12.30	8.70	3.66	5.64
1911	11.88	6.31	5.57	15.24	0.73	14.51	7.09	2.07	5.02
1912	14.61	10.73	3.88	19.14	1.60	17.54	7.39	2.37	5.02
Mean.	12.59	8.22	4.37	15.93	1.14	14.79	7.73	2.70	5.03
1908	16.05	12.17	3.88	10.16	1.06	9.10	4.88	0.24	4.64
1909	13.31	9.15	4.16	10.71	1.41	9.30	4.97	0.23	4.74
1910	16.85	11.68	5.17	10.28	0.85	9.43	5.03	0.40	4.63
Mean.	15.40	11.00	4.40	10.38	1.11	9.27	4.96	0.29	4.67

	Rainfall	Runoff	Evaporation	%	Rainfall	Runoff	Evaporation	%
1907	33.37	12.38	20.99	37	....	....	....	..
1908	....	....	....	..	32.69	13.47	18.62	42
1909	....	....	....	..	29.00	10.79	18.21	37
1910	....	....	....	..	32.16	12.93	19.23	40
1911	34.21	9.11	25.10	27	....	....	....	..
1912	41.14	14.70	26.44	36	....	....	....	..
	36.24	12.06	24.18		31.11	12.40	18.71	

At Chemung, N. Y., a few miles east of Elmira, the drainage basin has an area of 2,440 sq.mi.

The rainfall for the basin has been determined by averaging the records of well-distributed stations. In three of the six years recorded, 1907, 1911 and 1912,



MEAN RAINFALL AND RUNOFF ON THE CHEMUNG RIVER BY SEASONAL PERIODS

the greater part of the precipitation occurred during the growing season, while in the other years, 1908, 1909 and 1910, it occurred in the flood period. In the first-mentioned years the average rainfall was 36.24 in. and the runoff only 12.08 in. In the other three years the average rainfall was only 31.11 in., over 5 in. less than in 1907, 1911 and 1912, and yet the runoff was slightly greater, amounting to 12.40. In the years in which the greater part of the precipitation occurred during the flood period there was a greater annual runoff, for at this time the ground was in either a saturated or a frozen condition. During the growing and replenishing season the rainfall was less than normal and as a result it was practically all needed for vegetation and to replenish the groundwater supply, so that the runoff was very light. It should also be noted that the amount of the evaporation increased steadily from 1908 through 1911. This was due to the fact that each year the precipitation during the replenishing period was insufficient to saturate the ground and more of the precipitation which fell in the flood period of the following year was needed to replenish the groundwater supply. In the years in which the greater part of the precipitation occurred in the growing season a much larger amount of rainfall was used in vegetation, thereby decreasing the total runoff. The effect of the distribution of rainfall upon the amount of the annual runoff on the Chemung River is remarkable. It well illustrates the fallacy of such statements as "The runoff will be a certain percentage of the rainfall."

It is also evident from an examination of the table and diagram that the distribution of the precipitation has a marked effect on the amount of storage capacity necessary to maintain a certain stream flow throughout the year. In the case of the Chemung River, there was a greater runoff during the years in which the rainfall occurred largely in the flood period and at the same time the rainfall was so distributed in the other three years that the dry-weather flow was much greater. In all of the years in which the rainfall was heaviest in the flood period the runoff was extremely low not only in the growing period but also through the replenishing period, covering a period of seven months.

While it is not often the case as with the Chemung River that three dry years occur consecutively, still there are many streams for which the gagings for several years may show a high runoff during the latter part of the year and then there will be a year during which the rainfall is so distributed that the dry season lasts not only three or four months but for seven months, requiring a considerable revision of calculations of storage.

In the study of the relation between rainfall and runoff it is sometimes the case that the records of stream flow though only a few years in length have been kept during a year in which the rainfall was the least that occurred over a long period of years. From the above data it is evident that it does not necessarily follow that this year of least rainfall was the year of least total runoff during the period for which the rainfall records were kept. There may be a year for which the total precipitation was greater but in which the precipitation was so distributed that the total runoff would be less than in the year of least rainfall.

Sewage Works and Outfall for Lakewood, Ohio

A 7,500,000-gal. sewage-treatment plant consisting of bar screens, grit chambers containing adjustable vanes forming double bottoms, Imhoff tanks (see views herewith), sludge beds and liquid-chlorine disinfection apparatus is being built for Lakewood, Ohio, to take the place of plain sedimentation tanks and cinder contact beds built in 1900.

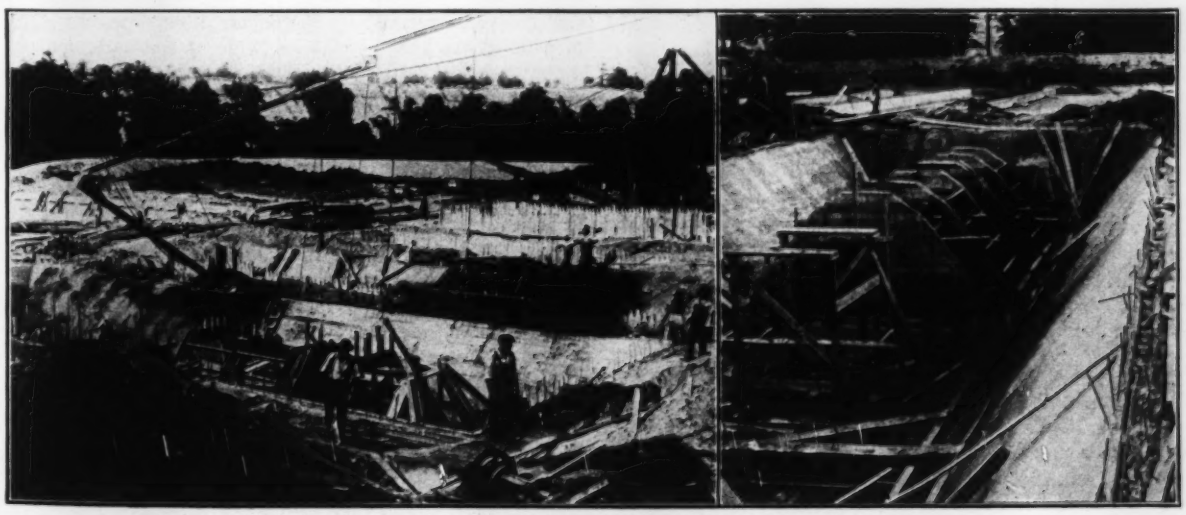
The old sedimentation tanks will be utilized to take the excess flow over and above 7,500,000 gal. a day, owing to admission of storm water into the sanitary sewers at times of heavy rainfall. From these tanks the excess flow will be pumped back into the new plant, at the entrance to the grit chambers, when the sewage flow is normal. A house will be built over the screen and grit chambers, which will contain a small incinerator for burning the screenings. The contractors for the sewage works are Lowensohn & Ule, of Cleveland. The contract price is $78,325, not including the chlorine apparatus and incinerator, contracts for which have not yet been let.

The effluent will be discharged through an outfall sewer extending 5,930 ft. to and then 1,500 ft. into Lake Erie, where the discharge will be through multiple outlets. The contract for the outfall to the lake has been let to Hoag & Dall, of Cleveland, for about $100,000. The lake section, which is estimated to cost $30,000 to $40,000, will probably not be let before next year.

For its first 2,280 ft. the land portion of the outfall sewer is of 36-in. reinforced concrete, which acts as an inverted siphon under low pressure. The sewer then extends for 3,000 ft. in tunnel, lined with vitrified segmental block to give an egg-shaped cross-section equal to a 54-in. circular sewer. Then comes 650 ft. more of 36-in. reinforced-concrete pipe, terminating at the lake shore.

The reinforced-concrete pipe is made in a near-by yard and is being laid under a guarantee for water-tightness—all by the Lock Joint Pipe Co., of New York City.

It has not yet been decided whether the 1,500 ft. of submerged outfall will be of steel, cast iron or reinforced concrete. Alternative bids will be received on all these materials. In any event the first 1,100 ft. will have a diameter of 36 in.; and the outer 400 ft., which will be perforated with 4-in. holes, will be reduced in size progressively. If the material chosen is steel, the diameter will be decreased from 36 to 24 in. gradually; but if cast iron or reinforced concrete is used, then the first 200 ft. will be 30 in. and the last 200 ft. 24 in. in diameter. The holes for the multiple outlets will be located so as to give an upward discharge from either side of the pipe at angles of 45°. The lake end of the



CONSTRUCTION VIEWS OF IMHOFF TANK AT LAKEWOOD, OHIO

outlet will be provided with a specially designed flap valve.

The treatment works and outfall sewer were designed in the office of R. Winthrop Pratt, consulting engineer, Cleveland. Construction is in charge of E. A. Fisher, city engineer of Lakewood, with R. L. Squier as resident engineer.

Tunnel-Concreting Methods

By L. G. Warren*

In concreting the 12-in. shell of the 9-ft. shore tunnel of the new water intake, Milwaukee, Wis., using hand shoveling into forms exclusively, the fastest speed of work attained was placing a section 12 ft. long in 5 hr. The average speed for 12-ft. sections was 5.90 hr., and the average speed for 8-ft. sections 5.64 hr.

The tunnel shell within neat line has about 1¼ cu.yd. of concrete per lineal foot, and there is about 20% excess concrete on the average, owing to excavation beyond the neat line. The mixture is 1:2:4, the stone ranging from ⅛ to 1½ in.

All mixing is done on the surface. A 9-cu.ft. mixer at one of the two shafts and a ½-yd. mixer at the other shaft furnish the concrete. Both mixers are driven by electric motors, after gasoline and steam engines were tried and abandoned; the motors have given satisfactory service. In the hopper of the ½-yd. mixer a partition was placed dividing the hopper into two compartments, for sand and stone respectively, of the exact capacity required for the batch. This minor device has proved to

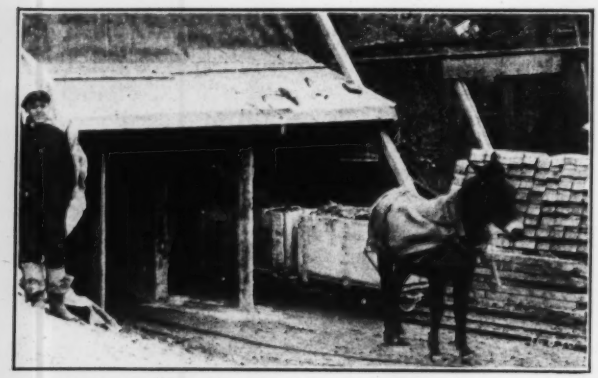


FIG. 1. WOODEN MUCK CAR CARRYING CONCRETE INTO TUNNEL

be a great time saver for the contractor and a comfort to the city inspectors.

Concrete is handled from the mixer to the heading in the regular tunnel cars used for carrying the excavation spoil. These are wooden ½-yd. cars (Fig. 1). Due to the rough handling which muck cars get, constant vigilance must be exercised to maintain them water-tight or grout-tight, if they are to be satisfactory for carrying concrete. At the forms, slick plates 30 in. wide by 12 ft. long, of ¼-in. steel, are used for receiving the concrete dumped from the cars. The shovelers work from these plates, when the forms up to the arch key plates are being filled. When this height has been reached, a platform is erected inside the forms. Concrete is then shoveled from the slick plates to the platform, from which two men shovel it upon the arch plates. These two men

*Resident Engineer, Shore Tunnel, Milwaukee, Wis.

FIG. 2. WOODEN FORM FOR CONCRETING TUNNEL SHELL, AND SHOVELING PLATFORM

also act as tampers, using wooden tampers to pack the arch concrete.

Both the Jackson steel segmental forms and plain wooden forms have been used. The wood forms consist of 2⅝-in. stave lagging on rings of 4x3x⅜-in. angle spaced about 3 ft. (see view, Fig. 2). They are built up as the filling proceeds, the installation of a section being one continuous operation, to secure monolithic construction. Junctions between successive sections, longitudinal of the tunnel, are secured by tongue-and-groove construction of the abutting ends of sections, close attention being given to ramming the fresh concrete into the groove of the exposed face of the preceding section. The groove is formed by a wooden piece 6 in. deep, 4 in. wide at the front and 3 in. wide at the back, nailed to the end bulkhead of the form in 3-ft. sections. The wedge shape makes the removal of these pieces easy and enables them to be used many times. The face of the preceding section of completed concrete is coated with a neat grout before the concrete is placed in any section. The mining crews act as concrete men for placing lining as soon as the excavation of a section is completed.

Measuring the time of individual operations involved in mixing for this concreting, the following figures were obtained: Shoveling 2 cu.ft. of sand from pile into measuring wheelbarrows, 35 sec.; the same for 4 cu.ft. of stone, 57 sec.; dumping cement, stone and sand into mixer, 21 sec.; mixing 22 revolutions, 100 sec.; dumping from mixer, 22 sec.; a total of 3.91 min. of the time of four men. The average time required in setting up angle ribs and temporary floor of the wooden forms was 40 min.

It has been found that care must be observed to provide a vent for the compressed air in porous ground, in

order to prevent rupture of the green concrete in the arch under the action of compressed air, especially when air loss is present above the arch previous to placing the concrete. Two fresh arches in the tunnel were cracked through this action when the headings were closed by tight bulkheads; in both cases there had been heavy air loss over the arch prior to placing concrete. The bulkheads acted as corks in a bottle and therefore the compressed-air pressure lifted the fresh concrete and cracked it. The cracks were closed by grouting. Following this experience an air vent was placed in every face bulkhead.

The tunnel is being built under the direction of George F. Staal, City Engineer, by the O'Brien & Jackson Construction Co.

Reinforced-Concrete Drift Catcher at Erie, Penn.

By Theodore E. Seelye*

The flood of Aug. 3, 1915, which did such a large amount of damage in the valley of Mill Creek in Erie, Penn., was much aggravated by the great quantities of drift brought down from the watershed above the city. The creek passed through the city in an open channel, which was carried under the street crossings through large culverts. During the course of the flood, these culverts for the most part became entirely clogged with drift, which caused practically all of the water to flow over the street intersections and thereby increased to a considerable degree the height of the flood water.

While the major portion of this drift had its origin in the city and consisted of the wreckage of buildings and outhouses, the outlying district was nevertheless a large contributor, the floating material consisting mostly of uprooted trees, stumps, chicken houses, etc.

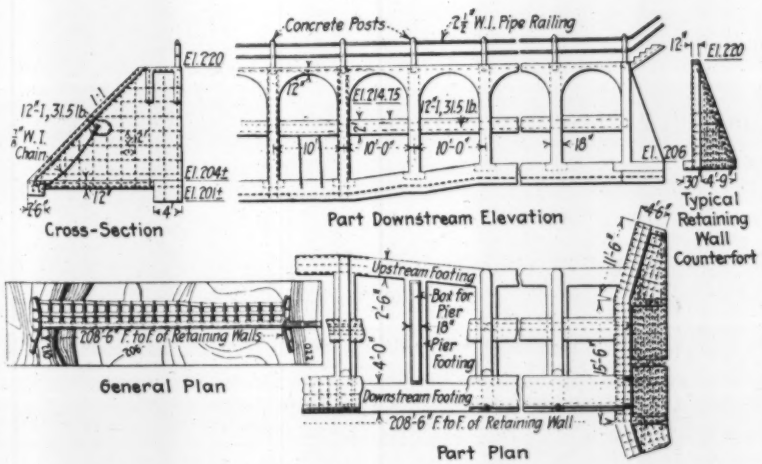
The proposed improvement of the creek now under way contemplates the construction of a large reinforced-concrete tube through the city to carry the entire flood flow of the creek. There will therefore be no drift originating within the city limits, and while the velocity through the tube will be so high and the design of the entrance such that there will be practically no chance for a lodgment of floating débris, it was considered wise as a precautionary measure to erect a structure to intercept the larger pieces coming in from the country.

For this purpose, the drift catcher illustrated herewith was devised. This might be described most simply as a hollow reinforced-concrete dam with the deck slabs omitted. The site chosen for the work lies in Glenwood Park, about three-quarters of a mile south of the city limits. This park, with the creek running through it from end to end, is the property of the city. An excellent site was available, permitting the construction of a long, low structure of the type indicated above, with a comparatively high bank on each end so that a maximum of water area was obtainable without the danger of backing the water up to a great height in case of clogging.

The drift catcher will be 208 ft. long between abutments, and will be about 16 ft. high, with a walkway across the top surmounted by an ornamental railing. The walkway is supported by arches between the buttresses, which are 10 ft. c. to c., to add stiffness. A heavy beam of oval section connects the buttresses near their upstream edges at about half the height of the structure and serves to suspend heavy chains which are fastened again to the foundation. These chains are planned to retain the smaller débris coming at the beginning of a flood. The entire structure rests upon a foundation of rock and is designed with a view to offering a pleasing architectural addition to the park.

The construction will be performed by contract under the supervision of Farley Gannett, Consulting Engineer, Harrisburg, Penn. Faulkner G. Lynch is City Engineer. The contractor performing the work is A. G. Diefendorf, of Erie.

*Of the firm of Farley Gannett, Consulting Engineer, Harrisburg, Penn.



DETAILS OF STRUCTURE TO CATCH DRIFT IN ERIE FLOOD-PROTECTION WORKS

Making the Most of Federal-Aid Road Appropriations

By D. A. Thomas*

With a view to using the money apportioned to Michigan during the next five years under the Federal-Aid Road Act, State Highway Commissioner Frank F. Rogers has formulated a plan that will permit the completion of the state's trunk-line road system through the poorest counties. It remains for the legislature to enact the necessary legislation.

Nearly all the trunk lines have gaps in them where they run through the poorer counties. This is particularly true of the East Michigan Pike and the West Michigan Pike, which skirt respectively the east and west borders of the lower peninsula and form a part of the Dixie Highway. Under the present state-highway laws it would be quite impossible to fill the gaps for many years to come, as the poorer counties and townships cannot stand the financial strain. It is in such locations that it is proposed to use the Federal aid. The Federal-Aid Road Act apportions to Michigan during the next five years $2,186,756. This money can be secured only by meeting it dollar for dollar, thus insuring the spending of $4,376,512 on Federal-Aid roads during the period.

*Michigan State Highway Department, Lansing, Mich.

In order to arrive at an equitable distribution of the cost among the Government, state and counties a unit known as the valuation per trunk-line mile has been developed by dividing the assessed valuation of any county by the trunk-line mileage within its borders. The values for this unit vary through a wide range of from $25,233 to $16,320,156.

Counties with an assessed valuation per trunk-line mile of less than $100,000, of which there are 19, are classed together; those from $100,000 to $200,000 are placed in a second class, and so on up to those of $500,000 or more, of which there are 27.

A schedule is proposed which would require the counties of the first class (the poorer counties) to pay 25% and the state 25%, while the Federal aid will make up the remaining 50%. In each succeeding class the counties' share would be increased by 5% and the state's decreased 5% until those richer counties in the last class would be required to pay the full 50%.

Such a distribution as is outlined above will impose no great hardships upon the poorer counties. The state will also be called upon to contribute less toward the construction of the roads than under the present reward system, which provides for the payment of state rewards of from $500 to $3,400 per mi. on trunk-line roads constructed according to the specifications of the State Highway Department.

Since the cost of the Federal-Aid roads will be less to the state in most cases, it is expected that the legislature will increase the reward on the more expensive types of roads, which will materially aid the richer counties to build the class of roads commensurate with their traffic. Thus the best interests of the whole state will be served.

More on Bolted and Lagscrewed Joints in Timber

By H. D. Dewell*

In discussing the tests of bolted and lagscrewed timber joints in the articles "New Tests of Bolted Joints in Timber Framing" and "Lagscrewed Timber Joints," *Engineering News*, July 20 and 27, 1916, there were certain omissions and errors. It is believed also that the reasons for certain of the deductions made and the conclusions drawn may not have been clear.

Theory of Action of Bolted Joints

On page 112, in stating the different formulas for bolt bending, the total load on the joint is P and not $2P$. This error will be obvious to one reading in detail.

Referring to Fig. 4, page 114, the side note to the figure should read "P = Total load on joint = $2(P_2 - P_1)$. In the definition of terms, following, d = the diameter of the bolt and not the width of timber and splice pads, as there stated.

In Table 1, item 7 gives the values corresponding to a slip of $\frac{1}{32}$ in. or 0.03125 in., and not 0.025 in., as there stated in the footnote.

In the same table, item 9 should not appear. The author recommends as working values the figures given in item 8, which are those computed according to the theory discussed in the text.

The theory of bolt action advanced rests upon the assumption that, beyond a certain minimum value of l (width of side timbers or one-half the width of center timber), the strength of the joint is independent of the length of bolt and that such a value for t in the sketch may be found that the moment in the bolt will just equal the flexural strength of the bolt. This assumption, in principle, is similar to that of Prof. H. R. Thayer, as discussed in his "Structural Design," Vol. 1, the difference being in the assumed distribution of load on the bolt, the resulting moment and the capacity of the joint.

The maximum moment on the bolt in the sketch will occur at a point of zero shear. There are five such points,

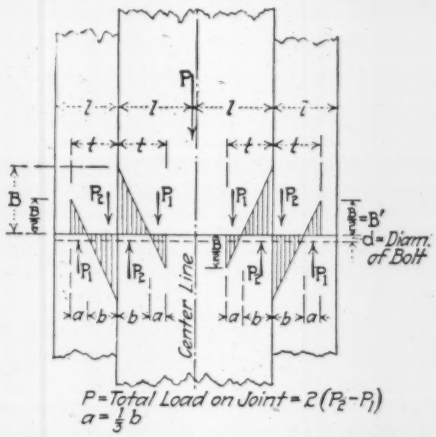


FIG. 1. PRESSURE DISTRIBUTION IN BOLTED TIMBER JOINT

Distribution as deduced from tests and used for calculations. Diagram should replace Fig. 4, p. 114, July 20, 1916

two each side of the center line of joint, at a point x (not marked in the sketch) which is distant $\frac{1}{2}\ b$ or a either side of the contact faces of the timbers, and one at the center of joint. In the total length of bolt there are four points having equal maximum bending moments.

The following equations lead to the expression for the maximum moment for the conditions of the sketch. Let the bending moment be computed for the point x, distant $\frac{1}{2}\ b$ to the left of the left contact face of timbers:

$$M = P_1\left(\frac{t}{3} + \frac{2t}{9} - \frac{t}{9}\right) = \frac{4P_1 t}{9} \qquad (1)$$

$$P_1 = \frac{1}{2}\left(\frac{B}{2} \times \frac{t}{3}\right) d = \frac{Btd}{12} \qquad (2)$$

$$M = \frac{4}{9} \times \frac{Btd}{12} \times t = \frac{1}{27} dBt^2 = \frac{2}{27} Pt^2 \qquad (3)$$

The resisting moment of the bolt is $\frac{\pi d^3 S}{32}$. Equating the bending moment to the resisting moment, there results

$$\frac{1}{27} dBt^2 = \frac{\pi d^3 S}{32} \qquad (4)$$

Solving for t,

$$t^2 = \frac{27\pi d^3 S}{32Bd} \qquad (5)$$

and

$$t = d\left(\frac{27\pi S}{32B}\right)^{\frac{1}{2}} \qquad (6)$$

A value of t may thus be found for each diameter of bolt, working values for the bearing stress B and the bolt bending stress S having once been established.

$$P = 2(P_2 - P_1) = 2(4P_1 - P_1) = 6P_1$$
$$= \frac{6Btd}{12} = \frac{1}{2} Btd \qquad (7)$$

*Civil Engineer, 58 Sutter St., San Francisco, Calif.

For joints in which the distance l is less than t, it is held that the bending moment on the bolt varies between the limits $M = {}^2/_{27}\ Pt$ and $M = \frac{1}{3}\ Pl$, and the safe load on the joint varies correspondingly between the limits $P = \frac{1}{2}\ Btd$ and $P = Bld$. At the latter limit, the pressure diagram is triangular in shape, the unit pressure being zero at the outer edge of the splice pad and a maximum of B at the face of the center timber. All of the above discussion tacitly assumes that the ratio of the diameter of the bolt to the thickness of side timber is such that the flexural strength of the bolt is reached with the triangular pressure diagram. With a joint in which the diameter of the bolt is relatively large as compared with the thickness of splice pads, the pressure diagram may be trapezoidal in shape, with the largest pressure always at the inner face of the splice pad. The final limit in this direction, or the maximum load that the joint can take, will be when the pressure diagram becomes rectangular in shape. In other words, there will then exist a uniform pressure along the length of bolt, the bending moment and the total load being represented by $M = \frac{1}{2}\ Pl$, and $P = 2\ Bld$ respectively. The whole argumentation may be summarized by the statement that the theory proposed holds that the bending moment on the bolt varies between the limits $M = {}^2/_{27}\ Pl$ and $M = \frac{1}{2}\ Pl$, and the capacity of the joint varies between $P = \frac{1}{2}\ Btd$ and $P = 2\ Bld$, the relation between the bending moment and the total load always being such that the safe flexural strength of the bolt is reached, unless the diameter of the bolt is so great that a uniform pressure distribution of bearing along its length does not stress it in flexure to its safe capacity; and, with the last reservation, the pressure distribution on the bolt is such that the maximum unit stress in bearing for the timber is reached at the contact faces of the joint.

Working values for bolted joints with varying thicknesses of timbers are best found by means of plotted curves, similar to those of the accompanying figure, which illustrates the method of finding the safe capacities of joints where the relative sizes of bolt diameters and thickness of timbers determine the limits of bending moments and total loads as lying between $M = {}^2/_{27}\ Pl$ and $M = \frac{1}{3}\ Pl$, and $P = \dfrac{Bld}{2}$ and $P = Bld$.

Lagscrewed Joints

In the presentation of the results of the tests on lagscrewed timber joints there was an unfortunate error made in the values recommended for working strengths of lagscrewed joints where steel plates are fastened to timber. Thus, Table 1, page 163, July 27, 1916, should be modified as shown in Table 1 herewith.

Using the limiting deflection of $\frac{1}{16}$ in. as in the case of the bolted joint, with a factor of 2 for working loads, it is seen that the safe working resistance of a $\frac{7}{8}$-in. lagscrew in such a joint is 1,200 lb., and the corresponding resistance of a $\frac{3}{4}$-in. lag may be taken at 1,030 lb., based on the ratio of their diameters.

TABLE 1. STRENGTH IN POUNDS, OF LAGSCREWS FASTENING STEEL PLATES TO TIMBER

	¾x4½-In. Lag	¾x5-in. Lag
Kidder	2,100	2,800
Thayer	1,125	1,575
Tests*	1,200	1,200
Tests†	1,450	1,450

* One-half the values for limiting deflection of $\frac{1}{16}$ in. † Values for deflection of $\frac{1}{16}$ in.

Example of Use of Curves

Given: $\frac{7}{8}$-in. bolt, $l = 3$ in.

Method:

Resisting moment of $\frac{7}{8}$-in. bolt at 16,000 lb. per sq.in. = 1,050 lb. per in.

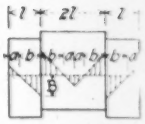
Since curves are for 1-in. bolt, equivalent moment for

$\frac{7}{8}$-in. bolt $= \dfrac{1.050}{0.875} = 1{,}200$ lb. per sq.in.

$M = Cl^2 = 1{,}200$ lb. per sq.in., and $C = \dfrac{1{,}200}{9}$ lb. per sq.in. $= 133.3$.

From curves, when $C = 133.3$, $K = 810$ lb.

Then $P = 810$ lb. $\times$ 3 in. $\times$ 0.875 $= 2{,}130$ lb.



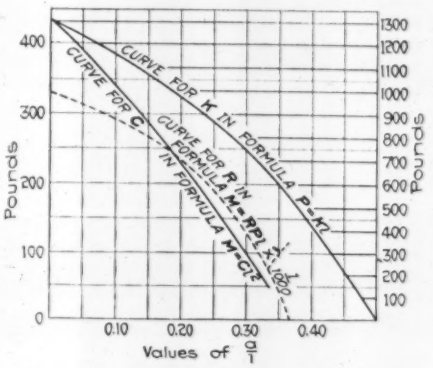


FIG. 2. VARIATION OF STRENGTH OF 1-IN. BOLT WITH THICKNESS OF TIMBER

Assumptions

1. Maximum pressure on ends of timber = 1,300 lb. per sq.in. on diametral section of bolt = B.
2. Diameter of bolt = 1 in.
3. Range of curves—
   $a = 0$ to $a = \frac{1}{1}$.
4. $M = \frac{1}{3}Pl$ to $M = \dfrac{2}{27}Pl$.

where

M = Maximum bending moment on bolt, and

P = Total load on joint.

5. For all values of $\dfrac{a}{l} < 0.33\frac{1}{3}$, the strength of joint depends on bending of bolt.
6. Pressure distribution on bolt is always triangular, with varying values of $\dfrac{a}{l}$.

Table of Values

$\frac{a}{l}$	R	C	K
0	0.333	433	1,300
⅓	0.256	266	1,040
¼	0.188	163	866
⅓	0.074	48.2	650

The recommended working values for lagscrews, based on one-half the strengths shown by the tests at a deflection of $\frac{1}{16}$ in., are expressed in tabular form:

TABLE 2. RECOMMENDED WORKING VALUES FOR LAGSCREWS

	Pounds per Screw
Metal plate lagged to timber, ¾x4½-in. lagscrew	1,030
Metal plate lagged to timber, ¾x5-in. lagscrew	1,200
Timber planking lagged to timber, ¾x4½-in. lagscrew	900
Timber planking lagged to timber, ¾x5-in. lagscrew	1,050

For detail information regarding the action of the various joints under load, the following table of results is submitted. This table should have appeared in the July 27 article.

TABLE 3. TESTS ON LAGSCREWED JOINTS

Summary of Results

Joint Letter or Number	Number and Size of Lags	Thickness of Side Pieces	Thickness of Center Piece	Load at Apparent Yield Point, Lb.	Load at Slip of ¼ In., Lb.	Final Load, Lb.	Final Slip, In.
7	Three ¾ in.	¼-in. steel pl.		6,500	7,700	20,000	0 92
8	Three ¾ in.	¼-in. steel pl.		5,500	6,700	19,700	0 75
9	Three ¾ in.	¼-in. steel pl.		5,000	6,700	30,000	1 14
17	Three ¾-in.	¼-in. steel pl.		8,000	7,500	30,000	1 15
A	Six ¾ in.	2 in.	8 in.	26,000	12,500	49,100	1 40
B*	Six ¾ in.	2 in.	8 in.	20,000	14,400	34,000	1 61
C	Six ¾ in.	1½ in.	8 in.	20,000	12,400	34,000	1 49
D	Six ¾ in.	2 in.	8 in.	25,000	10,700	44,400	1 09
E*	Six ¾ in.	2 in.	8 in.	20,000	10,400	33,000	1 70
F	Six ¾ in.	1½ in.	8 in.	23,000	12,000	33,400	1 14
G	Six ¾ in.	2 in.	8 in.	22,000	13,800	44,700	1 44
H	Six ¾ in.	1½ in.	8 in.	17,000	9,400	28,885	1 30
I*	Six ¾ in.	1½ in.	8 in.	11,500	8,500	20,000	0 53†
J*	Six ¾ in.	2 in.	8 in.	.....	10,500	14,000	0 13†

* Indicates that lagscrews had bearing across the grain of the center timber. In joint J, the load was removed at 14,000 lb., when the joint came back immediately to a deflection of 0.10 in. Its final recovery was not noted. The final loads do not necessarily indicate the ultimate strength of the joints. † Load removed.

Notes from Field and Office

Railway chief engineer discusses night work—Railway methods applied to highway-bridge erection—Earth fill six miles long contains 1,700,000 yd.—Pile tests in Chicago—An odd street intersection—Contractors' cost records—Garden-hose finish for concrete pavements—Water lifts sand to filters

Cost of Night and Day Work

By Hunter McDonald*

In connection with the relative cost and efficiency of night work and day work, as discussed in *Engineering News*, Aug. 17, it has been my experience that the ordinary grading contractor uses every means and argument in his power to avoid doing night work when called upon to do so by proper authority. One of his principal objections is that it requires a very good organization to handle a double shift. Furthermore, the ordinary contractor is not equipped with lighting apparatus, which is absolutely essential to handle night work successfully.

My experience, based on railway construction purely, has also been that while the contractor has proceeded to put on a night shift when required, he has not made the proper effort to get the best results. Owing no doubt to his desire not to incur the additional plant expenses, the work has been poorly lighted, and the consequent wrecks to dump trains have materially cut down the output. Contractors also claim that night work cuts down the efficiency of the day force, on account of loss of time in making repairs to tracks or equipment damaged by the night force.

Under the best conditions of which I have knowledge, I would say that the night shift has had an output of about 85% of the day shift, but the average is considerably lower, probably around 66%. Of course, the season of the year cuts considerable figure. My experience has led me to believe that it is best to insist upon the work being sufficiently covered with plant to enable the contractor to finish within his time limit without the necessity of doing night work, and to insist on night work only as the last possible resort when the work has been delayed for other reasons over which no one has control.

In tunnel work I have found that the night shift makes practically the same progress as the day shift.

*Chief Engineer, Nashville, Chattanooga & St. Louis Ry., Nashville, Tenn.

Erecting Highway Bridges Under Traffic; Michigan

By C. V. Dewart*

In addition to consultation, preparing plans and general supervision of all highway-bridge work, the Michigan State Highway Department is called upon to plan, build, maintain and pay for bridges of over 30-ft. span on the state trunk-line roads, which constitute a 5,000-mi.

*Bridge Engineer, Michigan State Highway Department, Lansing, Mich.

FIGS. 1 TO 4. ERECTING HIGHWAY BRIDGES UNDER TRAFFIC IN MICHIGAN

Fig. 1—Concrete arch erected under traffic. Fig. 2—Steel trusses of new bridge erected outside old bridge. Fig. 3—Concrete floor of new bridge laid half at a time. Fig. 4—Bridge abutment properly designed

system connecting all of the principal cities of the state. During the last three years the state has built (or is building) 80 bridges ranging in cost from $2,000 to $10,000.

The maintenance of traffic on railroad bridges while under reconstruction is general, but until a few years ago the maintenance of traffic on highway bridges under the same conditions was unusual. The trunk-line bridges we have built, with few exceptions, are on main traveled roads, and in many cases, such as the Whitefish River bridge near the town of Rapid River, the bridge under construction is the only connecting link for miles around. Add to this the greatly increased automobile and through traffic, also the fact that when the state does the work the local inhabitants expect more than if they were doing it themselves, and there is reason enough to justify our policy of maintaining travel on all trunk-line bridges. The exceptions to this rule are few.

Maintenance of traffic during construction of an arch can be done by pouring one-half of the arch ring at one time and then turning traffic to the completed half, as illustrated in Fig. 1. This is becoming fairly common in the construction of large bridges. When time is too short to allow proper setting of the arch ring, this method may still be followed by boxing around the supports of the old bridge, where they pass through the arch ring. The full width of the arch ring may be poured at one time, and as soon as it has set sufficiently to carry the load the old bridge supports may be cut off on the line of the extrados, shifted to the arch ring, the holes in the ring poured and the backfill made.

For concrete arches and small-span bridges, however, there is comparatively little difficulty encountered. Generally traffic may be maintained in these cases by grading down the approaches to a short temporary wooden span on one side of the proposed bridge site.

Long-span steel bridges present an entirely different problem. Our pony-truss designs, which are standard for spans from 70 to 100 ft. inclusive, have the trusses placed about 3 ft. farther apart than the ordinary old-style trusses and may be erected complete with the new trusses outside of the old and the new floor system underneath the old.

The trusses in this case may be erected by three distinct methods: (1) By building falsework under each panel point and proceeding in the usual manner; (2) by the construction of temporary supports for the trusses, which are erected one at a time in a horizontal position alongside of the old bridge and then swung into a vertical position (the same set of supports is then used on the opposite side of the bridge); (3) by the use of hangers supported from the top chord of the old bridge the new trusses are erected in their final position without the use of falsework of any kind below, as shown in Fig. 2.

In the second and third cases the floor-beams and lateral sway bracing are swung into place from below. Next all plank and stringers of the old bridge are removed from one-half of the roadway only and stringers for the new bridge placed on this side, maintaining travel on the opposite side of the bridge. Then the old floor system is replaced, traffic restored to this side, the old floor removed on the opposite side and the second half of the floor system completed in the same manner as described for the first half.

As soon as the new trusses are completely riveted, the old bridge may be removed complete or blocked up at the floor-beams and removed piecemeal. The former method is much preferable, however, when there is some place where the old bridge can be used to advantage. It may be relocated on some near-by road of lesser importance crossing the same river, without knocking it down and then rerecting. All this may be done with very little if any interruption to traffic, provided forethought is used in the arrangement of floor planking.

With the old bridge removed and the plank of the old bridge relaid on the new floor joists, it is a simple operation to remove the plank on one half of the roadway at a time, pour the concrete floor on this half, then turn traffic to the completed half of the concrete floor and pour the concrete of the second half. A standard concrete floor with a vertical construction joint along the center line of the road is shown in Fig. 3.

We find that the second and third methods, or some modification of the two, have resulted or would have resulted in a very material reduction in cost of erection for nearly all cases, and in some cases we have found that the third method of erection has cost less with traffic maintained than the first method without traffic.

It is often necessary to erect the new trusses below their final elevation in order that the new floor-beams may be placed without interference to the old floor system. Our standard steel bridges up to 80-ft. span with plate expansion supports have a minimum depth of casting of 6 in., and for spans of 80 ft. and over a minimum depth of casting of 12 in. under the fixed end, or at the expansion end 6 in. under the rollers and 6 in. of geared segmental rollers. By the omission of castings and rollers at the start, from 6 to 12 in. may be gained for erection purposes. Stringers framed into the floor-beams constitute another advantage in this case; the top flange of the floor-beams of the new bridge may be erected in the same plane as the bottom flange of the floor-beams of the old bridge without interference.

All this generally provides plenty of room to complete the erection of the new bridge without jacking up the old bridge and thereby making a very objectionable hump in the roadway during the entire time of erection. The elevation of the old floor is not changed until the new bridge is completely erected. It is then only a matter of a few days to remove the old bridge, relay the wooden floor and jack the new bridge up to its final elevation. It is of primary importance to design the bridge seats in such a manner as to provide plenty of room for the jacks (see Fig. 4).

Too much cannot be said against the usual practice of boxing in or "pocketing" an end pedestal. How much has been preached against this practice, and yet how very few of the abutment seats that have been built recently are of the proper design! The cost is no more; the fault lies either in ignorance or in the total disregard of the requirements of an abutment. "Pocketing" a bridge seat accumulates dirt and corrosion, interferes with erection and maintenance and is altogether wrong from an æsthetic point of view.

With a little care in designing and staking out a bridge, the abutments and piers may be built up complete without in any way interfering with the old bridge or its foundations. This is certainly worth while whenever it can be done.

Slide Rule for Re-Gearing Water Meters

The accompanying sketch shows an improvised slide rule devised by F. L. Bock, Assistant Engineer, Distribution Section, St. Louis Water-Works, for the use of nontechnical employees in computing any combination of change gears in re-gearing water meters to register accurately. There are three pieces to the rule, the central one sliding between the outer two. The logarithmic graduations on the top and middle piece are seen to be those of an ordinary slide rule. The bottom piece contains only directions for use.

The proper gears are found after a test in which the per cent. accuracy and the number of teeth on both old gears are known. These data are applied as directed

TRAIN-GEAR NUMBER
DIAL-GEAR NUMBER (Step No. 4 – % Accuracy)
1, Set Pointer on Train-Gear Number on Upper Scale. 2, Put Dial-Gear Number on Lower Scale at Pointer. 3, Move Pointer to Arrow-Point on Lower Scale.
4, Put % Accuracy (on Lower Scale) at Pointer. 5, Move Pointer again to Arrow Point on Lower Scale.
6, Then set Proper Arrow at Pointer to get the new Combination Train-Gear Number (on Top) / Dial-Gear Number (Beneath) for correct Registration.

SLIDE RULE FOR RE-GEARING WATER METERS

on the six steps given on the rule. The "pointer" referred to corresponds to the hair-line on the rider of an ordinary slide rule. This device has been found very convenient in the Meter Branch of the St. Louis Water Division, Department of Public Utilities.

Long Fill Built from Borrow

The heaviest earthwork on the new line of the Vandalia R.R. between Indianapolis and Frankfort, Ind., is on the first six miles north from the connection with the present line at Ben Davis (outside of Indianapolis). As the line is intended for high-speed traffic, all grade crossings are avoided; and as the country is flat this necessitates a high fill for about six miles, interrupted only by bridges.

The average height of fill is 26 ft., and the total quantity will be about 1,700,000 cu.yd. for the present single-track fill. The width at subgrade for single track is 24 ft. (36 ft. on future double track), but in construction a width of 32 ft. is given, to allow for the washing and sloughing of new slopes. The shrinkage averages 4%, and the top of the fill is kept about 1.5 ft. above grade line.

The material for this fill is obtained from a borrow pit about 1½ mi. from the railway, where 70 acres of land were purchased, including a hill. The material in the hill is earth, clay and gravel, the last occurring in pockets so that it cannot be utilized for ballast. Below the normal ground line is clay. Numerous springs were cut in the hill, and the water made this clay stratum so soft that the steam shovels could not cut very deep below the ground level. As all the material available will be needed for the fill, it is planned to lay tile drains across adjacent property at the east end so as to drain the borrow-pit site into a neighboring stream. When this is done, an additional cut will be made over the entire site. A surface drain in the bottom of the cut now discharges into a farm drainage system.

The excavation is being done by two 70-ton steam shovels working on opposite sides of the hill, as shown in Fig. 1. One of these has a 2½-yd. and the other a 2-yd. bucket. The track is kept laid close up behind the shovel, so that as soon as it has finished a cut it can be run back and set in place for the next cut. This track then becomes the new loading track, the former loading track being gradually taken up and relaid behind the shovel as the machine advances. The steam-shovel cuts are about 1,400 ft. long, with a maximum depth of 40 ft. Water is pumped from a creek to a tank on top of the hill, from which gravity pipes are led to the shovels and to a tank for the locomotives. Coal for the shovels is delivered by the dump-cars.

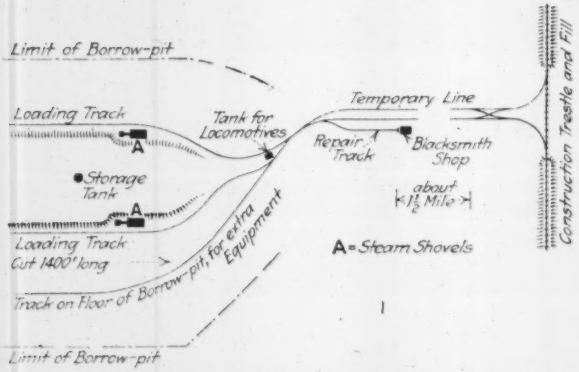


FIG. 1. BORROW PIT AND TRACKS FOR A BIG FILL ON INDIANAPOLIS & FRANKFORT R.R.

FIG. 2. BUILDING 26-FT. FILL FROM TRESTLE

A temporary trestle is used for making the fill, this being diverted around bridge sites so that the trains can dump at any desired points. These trestles have four-pile bents (with outside batter piles) with log caps, diagonal bracing and three lines of girts. The bents are spaced 14 ft. c. to c. The stringers are pairs of 10x16-in. timbers 28 ft. long. These are much larger than the stringers commonly used on temporary trestles, and they are recovered from the fill, only the piles and caps being left in place. Fig. 2 shows a train dumping from the trestle. After the fill reaches the top of the trestle, it is widened by means of a Jordan spreader, which throws over the side of the fill the material dumped from the cars.

The borrow pit is reached by a double-track temporary spur about 1½ mi. long, so that the trains from the two steam shovels can be handled independently. The

tracks are connected at both ends of the line, as shown in Fig. 1, and the spur is connected with the line on the temporary trestle by means of a Y, so that filling can be done in either direction.

The material is handled by standard-gage equipment, with six-wheel 55-ton locomotives hauling 12- and 15-car trains of 12-yd. side-dump cars. The cars are dumped by hand, the contractors considering this preferable to air dumping. The steam shovel loads them in such a way that one or two men can dump a car readily, as soon as the side chains are removed. About four trains are operated, but extra locomotives and cars are kept on hand so that additional trains can be put on when necessary. With the longer hauls, a loaded train can be run out, dumped and returned while the empty train is being loaded at the pit. With four trains a progress of about 6,500 cu.yd. per day is made. The yardage is determined by borrow-pit measurements, cross-sections being taken every 30 days.

A force of about 120 men is employed on this earthwork, including those on the dump, in the trains and at the borrow pit, and also the trestle men. They work a 10-hour day. As work has been delayed by scarcity of labor, a 10-hour night shift will be put on, the borrow pit and shovels being equipped for electric lighting, and acetylene lights being used on the dump. There is about 5½ mi. of construction track, including the spur to the borrow pit. The rails (with frogs and switches) are supplied by the railway company, while the contractor supplies the ties, spikes and bolts.

The contractors are Dunn & McCarthy, of Chicago. The work is under the direction of F. T. Hatch, Chief Engineer of the Vandalia R.R.; H. T. Whitney is Engineer in Charge, and A. F. Dye is Resident Engineer on the six-mile residency that includes the heavy fill.

Making Pile Tests for the New Chicago Railway Station

Pile tests at the new freighthouse of the Pennsylvania Lines at Chicago showed practically no settlement under a 40-ton load after the third day and a maximum total settlement of 0.067 in. after 11 days. For each test three 40-ft. piles were driven till their heads were 1 ft. below city datum (water level in the river), an oak follower being used to put them down to the required depth. The test pile proper was driven first and then one pile on each side, the center-to-center spacing not exceeding twice the greatest diameter of the test pile. After the driving was completed, a pit 10x10 ft. was excavated and sheeted. On the test pile was a cap 12x12 in., 2 ft. long, secured by a drift bolt, and upon this were four timbers of the same size in two courses.

TABLE OF TESTS OF FOUNDATION PILES

At test pile No. 1....	North pile 0.316 in.	South pile 0.316 in.
At test pile No. 2....	West pile 0.098 in.	East pile 0.073 in.
At test pile No. 3....	West pile 0.078 in.	East pile 0.109 in.

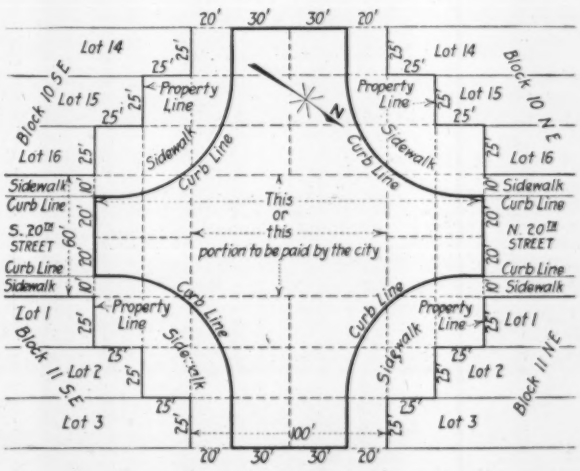
	Test Pile No. 1, In.	Test Pile No. 2, In.	Test Pile No. 3, In.
Settlement with 40 tons.....	0.023	0.056	0.027
First day after loading.....	0.000	0.000	0.006
Second day	0.007	0.000	0.006
Third day	0.001	0.011	0.000
Fourth day	0.001	0.000	0.000
Fifth day	0.000	0.000	0.001
Sixth day	0.002	0.000	0.000
Seventh to eleventh day.....	No further settlement		
Total settlement	0.034	0.067	0.040
Set for last blow.....	0.353	0.226	0.085
	Ft.	Ft.	Ft.
Maximum circumference	3.88	3.65	3.54
Minimum circumference	2.56	2.55	2.67

The upper timbers carried a loading platform 8x8 ft. of 3-in. plank. Upon this was piled about 40 tons of pig iron, an opening being left in the middle to permit placing the level rod on the head of the drift bolt. Measurements were made daily. The maximum results at the end of 11 days are shown in the accompanying table. The first three lines show the final set (under the last blow) of the six piles adjacent to the test piles. The remainder of the table relates to the test piles themselves.

The construction is under the direction of Robert Trimble, Chief Engineer of Maintenance-of-Way, Pennsylvania Lines. The Fitzsimons & Connell Co., of Chicago, had the contract for the piledriving.

Street-Intersection Problem

The accompanying sketch illustrates an interesting (and very likely unusual) problem in paving-cost assessment which has arisen in Middleboro, Ky., a city of about 7,500 population. The ordinance authorizes the improvement of Cumberland Ave. and intersecting streets, "at the cost of the abutting lots and parcels of land." A controversy arose as to what constituted the area of the very unusual street intersection at Cumberland Ave. and 20th St., which the city is to pay for. F. S. Lee, civil engineer of Middleboro, believes that Cumberland Ave., at its intersection with 20th St., runs back with the offset property lines, as shown in the sketch, to the frontage property lines of lots 16 and 1. Cumberland Ave. is 100 ft. wide between property lines except for the two lots at the corners of the intersection, as shown, where there are two offsets of 25 ft. each, on each side of the avenue, making it 200 ft. wide at the 20th St. intersection. The width of the avenue is determined by the position and distance apart of the property lines irrespective of whether they are continuous straight lines, offsets or any other shaped lines. Another contention is that the intersection of Cumberland Ave. and 20th St. cannot be over 100 ft. wide, but that lots 14 and 15 and 2 and 3, on their respective sides of the street and avenue intersection have a frontage of 25 ft. on the side street. The practice of other cities in similar problems and the opinions of other city engineers would be welcome.

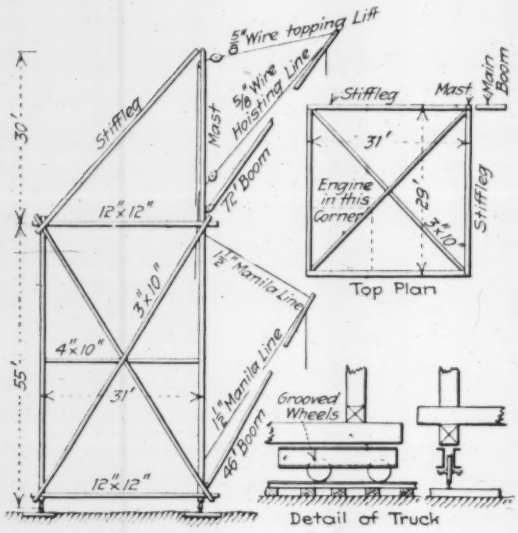


STREET INTERSECTION IN MIDDLEBORO, KY.

Tower Derricks for Erecting Steel Frames

The erection of the steel frame for the five-story freight station of the Pennsylvania Lines at Chicago was done by means of two traveling tower derricks of timber construction. The tower was 29x31 ft., 55 ft. high from the rails to the base of the 30-ft. mast. This mast was placed at one corner and was held by two stiff-legs. The boom was 12x14-in., 72 ft. long, trussed by four ⅝-in. cables, and carried a ⅝-in. wire hoisting line. The hoisting capacity was 7 tons, and the maximum lift, or vertical reach, was 124 ft. above the rails.

The tower was built of 12x12-in. posts (48 ft. high), top caps and bottom sills, with intermediate horizonal



TOWER DERRICK USED IN STEEL ERECTION

struts 4x10 in. Each side had diagonal bracing of 3x10-in. planks extending between the top and bottom corners, and similar horizontal diagonal bracing was placed at the top. The bottom was decked, and it carried (in the corner opposite the mast) a 30-hp. double-drum hoisting engine (cylinders 8x10 in.) and a vertical boiler. Under each corner was a two-wheel truck (tandem) with grooved wheels 14 in. in diameter. The gage was 31 ft. c. to c. of rails, each rail being laid on ordinary wood ties.

For handling the 12-ton girders used over the driveways on the second floor of the building a 14x16-in. boom 46 ft. long was stepped at the base of the post carrying the main boom. This was rigged with 1½-in. manila rope, using a 9-part line for the hoisting and a 7-part line for the topping lift. Few girders were handled each day, so no change was made in the hoisting plant; but the manila line was led to the niggerhead of the engine.

The 17,000 tons of steel was erected in this way in about seven months, averaging 150 tons per working day, by the Kelly-Atkinson Construction Co., of Chicago.

Time Saved in Ditch Design by Depth-Flow Diagrams

By Lewis M. Hammond*

In designing the distribution system of a large irrigation project it was found that it would be necessary to solve Kutter's formula a very large number of times. This is somewhat of a task, even with the best of the numerous curves and diagrams that have been devised. The main canals and laterals of this distribution system were carefully located on "grade contours," and had a uniform slope, generally about 0.001, but the small ditches, of from 3 to 18 sec.-ft. capacity, followed section lines or roads, and had every conceivable slope, from 0.00025 to 0.20.

To begin with, the two general types of ditches shown in Fig. 1 were decided upon. It was also decided to use an irrigating head of 3, 5, or 6 sec.-ft., and to use for n the values 0.013 for concrete-lined ditches and 0.0225 for unlined earth ditches.

Curves were then prepared showing actual water depth for various slopes, for various bottom widths, and for capacities of 3, 5, 6, 10, 12, 15 and 18 sec.-ft. A preliminary study of the various profiles gave the number of different bottom widths and the range of slopes that would have to be considered for each capacity. All the curves for any one capacity were plotted on one sheet. It took about two days to prepare the curves, and they have saved that amount of time many times over since then, for with these curves a ditch section could be designed at a single glance, without computing A, r, or v, from any of the numerous tables or diagrams which have been prepared for that purpose.

*Assistant Engineer, United States Reclamation Service, Provo, Utah.

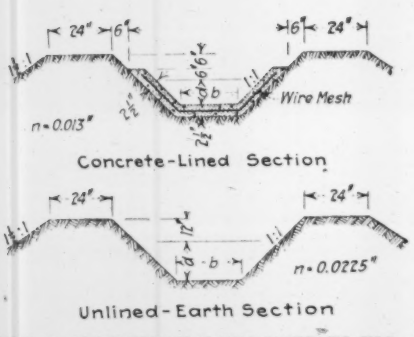


FIG. 1. SHOWING VALUES USED IN FIG. 2.

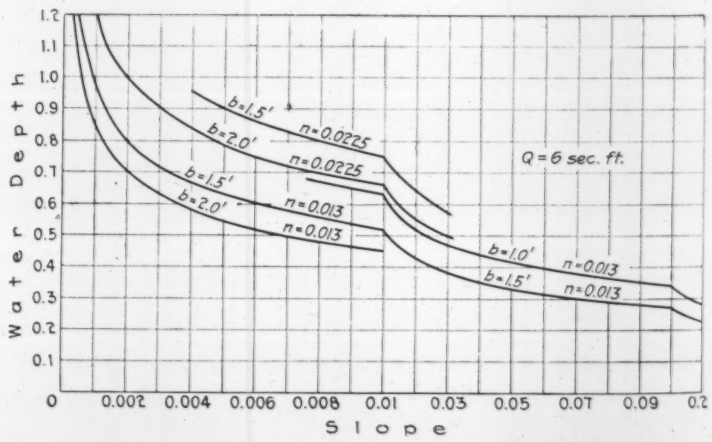
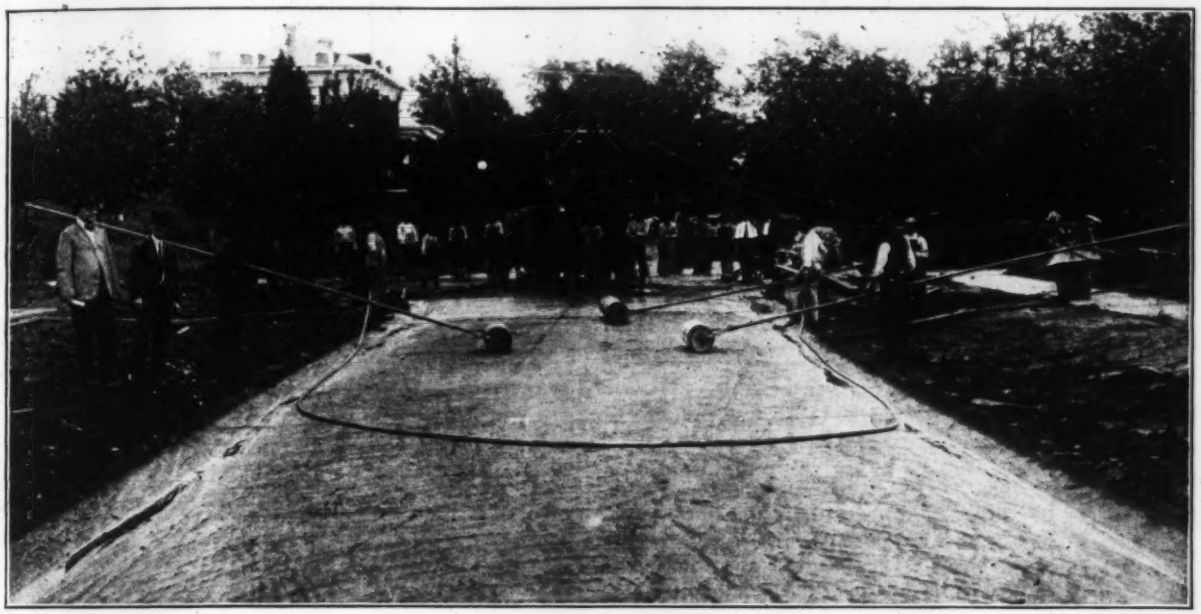


FIG. 2. SAMPLE CURVE USED IN DESIGNING DITCHES

Garden-Hose Finish for Concrete Pavements

Peculiar methods of finishing a concrete pavement surface are becoming as numerous as the varieties of a certain brand of pickles. The most recent one comes from the South and is said to have originated in Macon, Ga., where J. J. Gaillard is the city engineer.



FINISHING A CONCRETE PAVEMENT IN MYERS PARK, CHARLOTTE, N. C.

The illustration shows 70,000 sq.yd. of pavement under construction in Myers Park, a residential suburb of Charlotte, N. C. The contractor is W. C. Campbell, of Charlotte, who employed the following methods:

The concrete is formed to the shape of the finished roadway by means of wooden rollers 12 in. in diameter and 4 to 8 ft. in length. These are provided with long handles and are operated from either side of the road. Transverse joints are made at intervals of 30 ft. The joints are made with two thicknesses of two-ply tar roofing paper, so placed that they come to within ¼ in. of the surface, forming blind or concealed joints.

The surface finishing is done with an ordinary garden hose, made of rubber. This is dragged over the surface by two laborers from the concrete gang. The work is done at such times as the mixer is being moved ahead. No other finishing is given the surface.

Water Lifts Sand to Filters from Railway Cars

By William Gore*

About 6,000 cu.yd. of filter sand is required in the new Ransome drifting-sand mechanical filtration plant at Toronto, described in *Engineering News* of Sept. 21, 1916, p. 566. This sand is prepared at a local pit on the mainland and transported by railway cars to the site, being carried on scows for part of the distance. The lifting of the sand from the railway cars into the filters is done by water carriage, a method now commonly adopted in slow sand filtration practice. A point of interest in this case is the use of the comparatively low-pressure water-supply provided by the filter washback system. This pressure at the level of floor of the railway car is from 25 to 35 lb. per sq.in. As the actual lift is 12 ft. and the distance of delivery is up to 150 ft., it is evident that a special type of lifter is required.

The experience with the trailing-orifice type of lifter in the sand washers adopted in the drifting-sand filter showed that sand could be lifted with pressures much

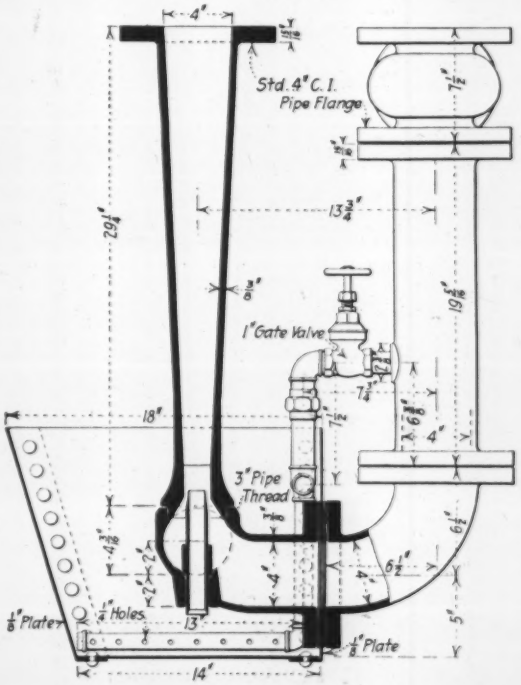


FIG. 1. DETAIL OF PORTABLE SAND LIFTER

*Consulting Engineer, John ver Mehr Engineering Co., 154 Simcoe St., Toronto, Ont.

less than usually adopted, and a modification of this type of lifter has been adopted. A section through the lifter is shown in Fig. 1, and views of it in use are given in Figs. 2 and 3. The hopper arrangement into which the sand is fed by hand and the water jets for forming

FIG. 2. SHOVELING SAND INTO HOPPER OF LIFT

a sand slurry are much the same as in Mr. Hazen's well-known design, but the water jet is vertical and continuous except for the 1-in. pipe that penetrates the throat along its axis and conveys the sand slurry from the bottom of the hopper to the center of the jet of water. The arrangement forms a kind of U-tube, the water being brought down one leg and the sand and water passing up the other leg. The bend at the bottom forms a convenient place to attach the hopper and to pass the sand into the water.

The object of the trailing orifice is to avoid, as much as possible, scour at the throat. In practice a very con-

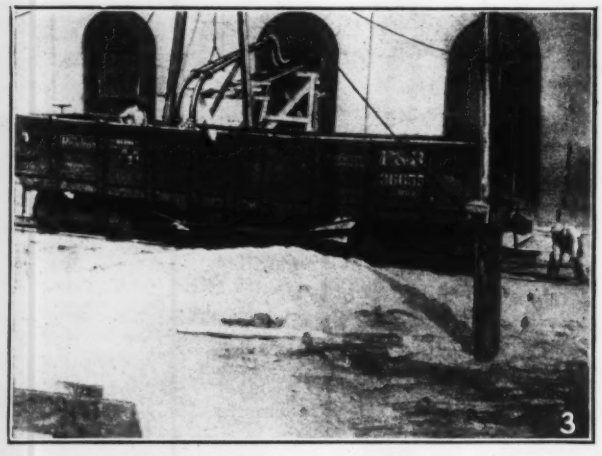


FIG. 3. HOW LIFT IS SUPPORTED FROM ABOVE

siderable vacuum is maintained at the throat; and although theory indicates that the trailing orifice gives a less effective suction than a right-angled connection, this is not noticeable.

It is found that the amount of water required is 12,500 Imp. gal. per hr. for a delivery of from 7 to 8 cu.yd. of sand per hour. There is therefore about 10% sand in the discharge. It was found necessary to rebush the throat of the lifter with a short length of 1½-in. pipe after about each 600 cu.yd. delivery. The scour observed appears to be due to eddy action commencing where the jet passes over the sharp edge of the sand-supply pipe.

In respect to scour, the experience with the lifter throat differs from that of the sand-washers, where the sand pipe is ¾ in. in diameter only and the disturbance therefore much less; besides the velocities are also several times less.

NOTES

Backfill Wrecks Plain Concrete Abutment—The abutment shown in the accompanying view failed for reasons that are obvious to any engineer. It was built by some Michigan township road commissioners without engineering advice or assistance. The bridge that the abutments were designed to carry is of 20-ft. span with a 16-ft. roadway. The height of bridge seat above the water surface is 22 ft., and the height above top of footing probably at least 25 ft. With this relatively great height the abutments were plain concrete without reinforcement and were not over 18 in. thick. The bridge spans the river in a deep gully, which necessitated an approach to the bridge over a high fill. In this section no other material was available for filling than sand, and with such material the backfilling was done. The result was that before the fill was complete the fine sand retained by the abutment exerted such pressure as to cause one wing wall to be broken off, as shown. A crack was also induced across the entire face of the abutment, which so affected its strength that timbers were placed between the two abutments to prevent the collapse of the entire structure. The standard plans issued by the Michigan State Highway Department for such bridges do not permit of unreinforced-concrete abutments of a greater height than 10 ft.—D. A. Thomas, Michigan State Highway Department, Lansing, Mich.

MICHIGAN TOWNSHIP BRIDGE ABUTMENT WHICH FAILED

Motor Trucks Used 1 Gal. of Gasoline per 11 mi. on a 500-mi. trip from the White factory in Cleveland to the Norton Grinding Co., Worcester, Mass. The trucks, which were 5-ton, were stopped only for replenishing the gasoline and oil supply and for meals for the drivers. The trip was arduous for the latter, but the army bodies of the trucks were filled with hay, so that the drivers took turns at sleeping and driving.

The Problem of Designing Flag Poles has been scientifically attacked by the Bureau of Yards and Docks of the United States Navy, which recently requested the Washington Navy Yard to make tests on standard flags to determine the stresses produced with different wind velocities. Two sizes of flags were used, one a No. 7, 3x5½ ft., the other a No. 8, 2½x4¼ ft. The flags were tried in wind velocities of from 20 to 60 mi. per hr. and the results show that the total horizontal resistance of a flag, exposed to a steady current of air, can be approximately represented by the formula $R = CAV^{1.9}$, where R = the resistance in pounds, A = area in sq.ft., V = velocity of wind in mi. per hr., C = 0.00030. The value of C decreases slightly with the size of the flag; that is, the resistance per square foot of area decreases slightly with the increase of size.

Editorials

Prizes Offered for Best Articles on Engineering Subjects

Cash prizes to the amount of $300 are offered by *Engineering News* for the best articles contributed on the four subjects stated below. For the best article submitted on each subject a first prize of $50 will be awarded, and for the article next in merit a second prize of $25. For other articles not receiving a prize, but deemed sufficiently meritorious for publication in *Engineering News*, a payment of $10 will be made. In comparing the different articles for the award of a prize, the controlling feature will be the value and interest of the information presented and the amount of information condensed within the limits of space named under each subject. No one need hesitate to take part in the competition because of distrust of his literary ability. In judging the articles, literary finish will be a very minor feature compared with the technical value of the information which is presented.

In case the two best articles submitted are found to be of substantially equal merit, the sum of the first and second prizes will be divided equally between the two authors.

All articles submitted in this prize competition must reach the office of *Engineering News* on or before Dec. 10, 1916. No article received after that date can be considered. The examination and award of prizes will be made by the editors of *Engineering News*, and the names of those receiving the prizes will be announced, if possible, in the issue of Thursday, Dec. 21. The submission of drawings and photographs with an article, to add to its interest and value, is encouraged, and the drawings may be presented in any convenient form.

Articles submitted in the competition should be addressed to the Editor of *Engineering News*, and the package should be marked on the outside, "For Entry in Prize Competition." Anyone is free to take part in the competition, but it should be clearly stated in the article whether the author himself is directly connected with the work that he describes or what the source of his information may be. This is in conformity to the well-known principle that every article published as professional data for engineers should show clearly the source from which it is obtained, so that the reader may know to what extent he may rely upon it as authoritative.

The four different topics on which papers are desired are printed below, with a suggestive explanation in each case of the field that the subject may cover. This explanation is not meant, however, to limit competitors in their treatment of the general subject.

1. *Rebuilding with Permanent Surface an Old Macadam Roadway*—There are in the United States many thousands of miles of roads and streets on which a water-bound macadam roadway has been built, often on a solid telford foundation. With the rapid increase in automobile traffic of the last five years particularly, the maintenance of these macadam surfaces has become a very serious burden. Various methods of treatment by penetration with asphalt oils, tar, etc., and covering with carpet coats have been used in the attempt to keep these roadways in fair condition. The expense of these methods of maintenance, however, and the unsatisfactory results secured have led to a general demand for the rebuilding of such roads, where traffic is heavy, with some form of permanent surface. In connection with this rebuilding, there is generally need for widening the old roadway, since with the high speeds of automobile traffic a greater width is generally deemed necessary for safety than was called for in the days of horse-drawn traffic.

The problem that is presented to a very large number of engineers, therefore, is whether in constructing a permanent paving of concrete, asphalt or other material the old macadam material, including the telford foundation, should be entirely removed or whether the new road should be built on top of the old as a foundation; how the subgrade should be treated; difficulties presented by the different crown of the old road and the new; whether material removed should be used on the shoulders of the road or carted away; and withal how to do the whole work within such moderate limits of cost per mile that the amount of money available may be made to cover a large mileage of streets. Length, 700 to 1,000 words.

2. *Operating Methods in a Drill-Sharpening Shop*—One of the most important factors in the economical operation of many contract jobs is the manner in which the drill-sharpening shop is run. Manipulation of the steel by the blacksmith, kind of steel to be used with different kinds of rock, experience with different brands of alloy steel and their heat-treatment are among the things that an engineer needs to know in order to secure the best results from his rock-drilling outfit. Length, 500 to 800 words.

3. *Dry Mixing of Concrete Materials at a Central Plant*—One of the newer developments in concrete work carried on in a large scale is the mixing of the stone or gravel, sand and cement at some central plant and transportation of the dry mixture to the place where it is to be used. Results of experience with this system are desired with an account of the advantages found, the difficulties experienced, detailed cost figures, etc. Length, 700 to 1,000 words.

4. *Adapting the Motor Truck to Its Work*—The rapid increase in the use of the commercial motor vehicle during the past year and a half is a matter of common knowledge. The high price of feed and of horses will continue to stimulate the use of motor haulage. The great variation, however, in the economic results reported indicates that selection of a motor truck suited to the work it has to do will make a large difference in the operating costs per ton-mile. Every user and prospective user of a motor truck is interested to know what features in design and equipment are found to be sources of trouble and what conduce to efficient and economical performance. Length, 700 to 1,000 words.

National Engineering Societies and Their Local Sections

Local sections of each of the great national engineering societies have been organized in the principal cities throughout the country. Many of these local sections have become strong organizations, holding regular and well-attended meetings, so that those belonging to the sections frequently testify that they are getting a more valuable return from their society membership through the local section to which they belong than in any other way.

A question that is coming up in rather acute form is the extent to which the national society, through its governing board, should control these local sections. In the American Society of Civil Engineers, the organization of the local sections has been a purely voluntary matter on the part of the members resident in a given locality. Nothing in the society's constitution authorizes the organization of such local sections, and they are in fact not even mentioned in the society's last Year Book. Apparently, therefore, each of these local organizations of the Civil Engineers is free to do exactly as it pleases and to manage its own affairs without any interference whatever from the society headquarters in New York.

In the American Society of Mechanical Engineers, on the other hand, the organization of the local sections was expressly authorized by a constitutional amendment that gave the society's Council entire control over the affairs of the local section. A substantial reason for this control is that part of the expenses of the local sections are paid from the general treasury of the society.

In most of the cities where these local sections of national societies have been organized, there has been also a movement toward the federation of all the engineering and scientific organizations in the city. Sometimes, as at Philadelphia, this federation is chiefly for social purposes, to combine in the enjoyment of club facilities, etc. In a number of cities, however, the general demand that the engineering profession shall exert an influence in public matters has resulted in the creation of committees or boards on which all the engineering organizations in the city are represented. This board is given authority to deal with public questions that may come up on which the opinion of the engineering profession may well be expressed.

The local associations of members of the American Society of Civil Engineers are free to take part in such movements. They have no authority to act for or represent their national society, of course; but because they have no official standing in the national society they are not accountable to it. The sections of the American Society of Mechanical Engineers, on the other hand, are by their charters subject to the authority of that society's governing board. The question whether that board shall permit its local sections to join other organizations in connection with public work is under active discussion.

There is, of course, no objection raised by anyone to these local sections uniting with other organizations to hold meetings, excursions, etc. The doubt arises when the proposition is made that these local sections shall take part in some public matter. In St. Paul, for example, the Minnesota Joint Engineering Board has been organized to represent three sections of the national societies, three local associations and the Engineering School of the University of Minnesota. Among the committees that are to carry on the work of this board are Committees on Public Affairs, Federal Legislation, State Legislation and Municipal Legislation.

A somewhat similar organization in the South is the Affiliated Technical Societies of Atlanta, made up of representatives from the local sections of five national societies and a representative of the Engineering Association of the South. This association, which has been in existence for three years, is apparently about to undertake similar work to that proposed by the Minnesota Joint Engineering Board. A recent circular issued by the Affiliated Technical Societies of Atlanta says:

> Like many others, you must have experienced a desire for a wider participation of engineers in nontechnical affairs, both local and national. The trend of the times is to force a greater civic responsibility on members of societies and upon professional engineers.

These two organizations are without doubt typical of a general movement in the engineering profession toward having its organizations exert an influence in public affairs. This movement is likely to take shape more rapidly in the local organizations than in the national societies.

The argument made by those who hold that the national society should strictly control its local sections and prevent them from taking action on public questions relating to legislation, etc., is, briefly, that no group of members should have the power to commit the society as a whole on any question on which the members of the society might hold radically different opinions. To take a concrete example: It might be that a local section in one city might take strong ground in favor of the enactment of laws to require the examination and licensing of engineers. A local section in another city might take an exactly contrary stand. It is urged that such conflicting opinions expressed by the sections would weaken the prestige of the national society.

Before accepting this view of the situation, it is well to inquire whether the acts of a local section, on matters of public interest, would be understood to represent the sentiment of the entire national society. Suppose, for example, that the San Francisco Association of Members of the American Society of Civil Engineers were to adopt a resolution favoring the passage of the national flood-control bill that was actively pushed at the recent session of Congress. No one would suppose that such action committed the entire society to the support of that bill. It is difficult to believe that the reputation and prestige of the national societies of Mechanical Engineers or Mining Engineers or Electrical Engineers would suffer because of the action that a local section might take on public questions coming before it.

If this is a correct view of the case, then the best policy for the national societies to adopt toward their local sections is the policy of noninterference. And this is a commonsense policy. It is not likely that a dozen engineers meeting once a month in New York City can wisely dictate what another group of engineers in a city a thousand miles away shall do or shall not do with reference to some local question.

The officers of the national societies ought to understand too, that it is still an open question whether their local sections are to be permanent bodies. There is no denying that in the local field it is the general organizations that are strong and influential and not the sections of the national societies. The most important development of the past dozen years in engineering-society work

has been the rapid growth in power and influence of such local societies as the Engineers' Club of Philadelphia, the Cleveland Engineering Society, the Western Society of Engineers and the Boston Society of Civil Engineers.

The prevailing sentiment in the profession is strongly in favor of the get-together movement, in which engineers of all branches of the profession join in a strong local organization. If the governing boards of the national societies adopt a policy of helpful coöperation toward their local sections, giving them financial aid from the national treasury and useful counsel in the conduct of their affairs, the sections may be an important aid in making the society's work nation-wide. If, however, a society adopts a repressive policy and attempts to dictate from headquarters what a section may or may not do, the probabilities are that the local sections in that society will soon cease to exist.

Steam Turbine at Sea Replaces the Reciprocating Engine

The remarkable success of the steam turbine in replacing the reciprocating steam engine is well known to engineers. For the propulsion of vessels, however, the reciprocating engine has held its own. Installations of steam turbines at sea have generally been confined to high-speed passenger and naval vessels. The difficulty in driving the screw propeller of an ordinary vessel by a steam turbine mounted directly upon the shaft is that the rotative speed at which the propeller is most efficient is very much lower than the rotative speed best adapted to the steam turbine. Even in the fast vessels driven by steam turbines a great deal has to be sacrificed. The turbines have to be especially designed to enable them to give good results at a moderate rotative speed and the screw propellers are made of finer pitch than would otherwise be desired to enable them to be run at a speed suitable for the turbines.

During the last years of active work of the late George Westinghouse, the engineering development in which he took the greatest interest was the Westinghouse-Macalpine system of speed-reduction gearing by which a high speed steam turbine drives a propeller shaft at low speed. With this combination it is possible to build a steam turbine which will be economical in the use of steam and can be built at moderate cost and the propeller speed is kept down to a rate suitable for such slow vessels as tramp steamers. The English steam turbine inventor, Parsons, also designed a system of speed-reducing gearing for use on ships, which has been applied to some extent, but it does not have the floating frame feature which was a characteristic of the Westinghouse-Macalpine system.

It is of interest to learn that the sanguine hopes of Mr. Westinghouse for this system of vessel propulsion are now being realized. The Westinghouse Machine Co. has recently received orders for equipping with its steam turbines and double-reduction gearing 44 merchant vessels now under contract in shipyards on the Atlantic and Pacific coasts, while contracts for 16 additional vessels are in immediate prospect. These figures do not include the orders for this class of equipment for United States naval vessels or for foreign governments. There is reason to believe that this development may mean the eventual replacing of the reciprocating engine by the steam turbine on shipboard.

Letters to the Editor

What Are Road-Maintenance Costs in New York?

Sir—The actual costs of road maintenance on New York State's bituminous highways have never been clearly stated. We have had, it is true, some extravagant guesses on the part of a former governor of the state, and annually there is given out a summary that combines all asphaltic and bituminous roads and gives a lump-sum statement as to what they have cost. But as to particular roads and the way in which the money spent on them is accounted for, no facts have up to this time been obtainable. For these reasons the figures presented herewith are of exceptional interest.

It appears that under the system followed in New York the cost of maintenance is distributed under the following headings: Improvements, Resurfacing, Engineering and Inspection, Ordinary repairs to road surfaces (which is divided to show the cost of labor and material separately), Cleaning macadam, Trimming shoulders and cleaning tops, Oil (which is divided into the cost of oil, sweeping, applying and covering and material for coverings), Guard rail, Concrete, Tools and Plant, Patrol, Extraordinary repairs and miscellaneous.

In the figures herewith, showing the cost of maintenance per mile per year on 24 roads, the items charged to engineering and inspection have been eliminated in arriving at the figure showing the cost per mile per year. One reason for excluding the charges for engineering and inspection is that the latter items do not cover labor and materials actually required to keep the road surface in repair. A further reason is that there appears to be no relation between the cost of engineering and inspection and the amount of money laid out for repair and materials. For example, road No. 646, built in 1910, has never been resurfaced, and yet we find that the charge against this road for engineering and inspection amounts to $620.35. In the case of road No. 686, where only $32 was spent for resurfacing, $631.39 was charged up for engineering and inspection. On the other hand, the records show a number of cases where large sums were spent for resurfacing and little or nothing for engineering and inspection.

Study of the New York maintenance sheets would indicate that the engineering and inspection charges were arbitrarily assessed against roads on which the labor and material outlay was negligible. Road No. 350 cost $3,651.92 for resurfacing in 1914. About $2,500 was

also spent for oil used on the same road, and yet the engineering and inspection charge is $768, or about the same as is charged against roads on account of which little or nothing was spent for labor and materials; and in the case just referred to the larger part of the engineering and inspection charge—namely, $596.17—appears under date of 1912, or two years before the larger amounts were spent in resurfacing and for labor and materials.

Another example that may be cited is road No. 5047, which cost $2,106 for resurfacing in 1914, but carries an engineering and inspection charge of only $217.83 for the five years it has been under maintenance.

All of the roads on which maintenance costs are here presented were constructed by the penetration method. They were not selected with a view to proving anything for or against this method of construction or the materials used. As a matter of fact, there was no opportunity to select any particular roads, the only figures obtainable for the purpose of this investigation being those here presented.

COST OF MAINTENANCE PER MILE PER YEAR ON 24 NEW YORK ROADS

Maintenance Cost, Less Engineering, on 12 New York Roads Constructed with Residual Asphalt Binder

Number of Road	Miles	Date Accepted	Total Cost, Maintenance and Repair	Maintenance and Repair Less Engineering	Cost per Mile per Year
5047	1.64	1911	$5,732.99	$5,515.16	$671
630	2.24	1910	10,250.58	9,352.48	696
735	7.90	1910	12,908.94	11,444.49	289
769	4.21	1910	7,163.90	6,471.33	307
5076	5.22	1911	5,646.06	5,091.26	244
5086	5.04	1912	11,263.49	9,886.67	654
630	4.25	1910	8,583.80	7,274.87	261
669	5.98	1913	5,896.15	5,575.59	311
654	5.35	1910	8,074.40	7,319.59	228
393	3.61	1910	6,593.50	5,849.75	324
350	7.26	1911	16,335.48	15,567.31	420
796	2.54	1910	21,324.67	19,547.76	705
Average maintenance per mile per year					$426

Maintenance Cost, Less Engineering, on 12 New York Roads Constructed with Fluxed Natural Asphalt Binder

Number of Road	Miles	Date Accepted	Total Cost, Maintenance and Repair	Maintenance and Repair Less Engineering	Cost per Mile per Year
719	5.56	1911	$6,369.37	$5,296.97	$190
5085	4.52	1913	5,068.79	3,971.34	293
5117	6.00	1912	6,328.65	5,999.26	250
415	3.37	1912	4,704.41	4,224.98	313
847	5.74	1912	6,689.44	5,717.34	248
571	2.61	1910	1,328.54	826.87	63
646	4.12	1910	3,724.80	3,104.45	124
650	5.66	1910	13,260.86	11,983.22	353
665	5.16	1912	4,656.48	4,145.07	201
686	8.72	1912	2,845.74	2,214.35	63
5054	2.00	1912	4,357.42	3,618.47	377
877	.97	1913	1,076.54	978.37	336
Average maintenance per mile per year					$234

While it would require a great deal of space to present in detail the distribution of maintenance on each of the roads listed, a few examples suffice to show how the records are kept and of what the totals consist. Typical of the maintenance sheets from which the accompanying table was made up are those relating to roads Nos. 719 and 5047. In these and all other cases the cost of engineering and inspection was subtracted from the total cost of maintenance. The remainder was then divided by the number of miles in the road to obtain the cost of maintenance per mile. This figure was again divided by the number of years the road had been under maintenance to obtain the cost per mile per year.

The two detailed statements here reproduced also serve to illustrate the lack of proportion between the cost of engineering and inspection and the amounts spent for labor and material. Road No. 5047 was resurfaced at a cost of $2,106, and there are other considerable charges for labor and material. Yet the engineering and inspection charge is only $227.83. Road No. 719 has never been resurfaced, is nearly three times as long as road 5047 and shows a much lower cost of maintenance per mile, yet it carries an engineering and inspection charge of $1,072.40.

DANIEL T. PIERCE,
Executive Assistant, Barber Asphalt Paving Co.
Philadelphia, Penn., Oct. 2, 1916.

Process Wanted for Protecting Drawings from Dampness

Sir—The Board of Water Supply of the City of New York will in a short time hang drawings in underground chambers and it will be necessary to protect these drawings from dampness.

About eight or ten years ago a man called with a process for casting drawings in a transparent solid which apparently was neither celluloid nor collodion, although it looked somewhat like either. We had no use for his scheme at the time but would like very much to try it now, so we would be very glad to hear from any of your readers who have run across this process or a similar one.

The drawings will be in some cases larger than 36x48 in. and should be made rigid enough to hang on a wall.

C. F. BELL,
Assistant Engineer in Charge of Drafting.
Board of Water Supply, Engineering Bureau, Municipal Building, New York City, Oct. 20, 1916.

Lubrication of Engine Cylinders

Sir—I have read with interest the article in *Engineering News* of Oct. 5, on "Oil in Engine Cylinders," in which is quoted the experience with one of our engines at the Rockwell Manufacturing Co.'s plant in Milwaukee.

As to the claim that their cylinder-oil consumption record surpasses all previous records of economic cylinder lubrication, I would say that this is not strictly a fact, as there are many vertical engines operated without any cylinder lubrication whatsoever, particularly marine engines.

The experience at the Rockwell Manufacturing Co.'s plant shows the advantage of the use of poppet valves and of carrying the weight of the piston on outside guides instead of carrying it on the bottom of the cylinder. The poppet valve has no rubbing surfaces and requires no lubrication. If in addition, the piston is turned smaller than the cylinder and supported on a stiff piston rod with a crosshead at either end, then there are no other surfaces to lubricate in the cylinder than the packing rings.

The nature and amount of friction of packing rings on cylinder walls are difficult to observe and determine; therefore there are no reliable data on this point. The friction, however, on a well-designed packing ring is exceedingly small. If it were not, then it would not be possible to run some engines without cylinder lubrication. It is very probable that a film of steam forms between the packing rings and the cylinder wall and aids the lubrication.

The lubrication of a steam cylinder is entirely different from the lubrication of a bearing. In a bearing, arrangements can be provided where the friction is reduced to a minimum. This condition could not be even approached in the lubrication of steam cylinders, and I do not think that the friction of a steam engine can be in any way reduced by increasing the amount of cylinder lubricant.

If the friction of the piston in a steam engine is not kept very low, this fact will manifest itself in wear and in cutting of the cylinder; as long as the amount of lubricant is sufficient to prevent cutting and wear on the cylinder, it is sufficient. In the cylinder of the Rockwell engine there is no sign of wear.

In a good many plants where city water is used for boiler feed and where the exhaust steam from the engine is used for heating purposes a considerable portion of the feed water is used over and over again, and in such cases it is very important to keep down the amount of cylinder lubricant used. BRUNO V. NORDBERG,

Chief Engineer, Nordberg Manufacturing Co.

Milwaukee, Wis., Oct. 5, 1916.

Dr. Travis and the Imhoff Tank

Sir—I have read with much interest your editorial note on "Dr. Travis and the Septic Tank" and also the description of the "Hydrolytic Sewage Tanks at Luton, England," by J. W. Tomlinson, both in your issue of Aug. 31, 1916. As I have had a good deal to do with the Travis tank, I would appreciate a little space in your paper.

As regards the origin of the Travis tank there is no doubt, and Dr. Travis has always fully acknowledged this, that the excellent work of H. W. Clark for the Massachusetts State Board of Health suggested to Dr. Travis further experimental research into the separation of the solids of sewage from the liquid and their separate treatment afterward, as a result of which he eventually evolved the well-known form of his tank. But the Travis tank is altogether a new constructional form and differs entirely from the two separate tanks used by Mr. Clark.

When Dr. Imhoff, in 1905, was an assistant in the Kön Prüfungs austalt für Wasserversorgung und Abwässer beseitigung in Berlin, he had before him the schemes submitted for approval by the Emschergenossenschaft for Travis tanks in one or two cases, and it was in his official capacity as "assistant judge" in examining into these schemes that he became acquainted with the Travis tank. On Apr. 1, 1906, Dr. Imhoff was appointed engineer to the Emschergenossenschaft, and on Apr. 28, 1906, he lodged the application for his German patent No. 187,723.

This patent, and this is important to notice, does not cover the form of the tank employed by Dr. Imhoff, for that was already patented to Dr. Travis; it only covers the prevention, as far as possible, of all movement in the sludge chamber and the passage back into the sedimentation chambers of the putrefying contents of the sludge chamber. This is clearly expressed in the judgment of the German High Court of Justice, delivered June 17, 1912.

I should like to point out here that it is another fallacy to assume that there is no movement in the sludge chamber. On the contrary, there must be violent motion according to the degree of putrefaction attained in it, and by closing the outlet this violent agitation is not prevented, but is rendered more or less arbitrary in its various currents. It further stands to reason that there must be a continual displacement of the contents of the sludge chamber into the sedimentation chambers, and it is well known that where the sojourn of the sewage in the sedimentation chambers is protracted the effluent from them is more or less septic.

It is only fair to add that down to the end of 1913 there had been erected in Germany 63 Travis tanks. In England, I am told, there are now about ten Travis tanks dealing with something like 3,500,000 Imp. gal. of sewage daily.

There are a number of Travis tanks at work in India. There is also one, if not two, I believe, in South America, but probably the largest Travis tank installation at the present time is at Cairo, Egypt, when daily 11,000,000 Imp. gal. are treated. H. ALFRED ROECHLING.

29 Broadway, Westminster, London, S. W., England, Oct. 3, 1916.

Goose Lake Valley Irrigation System, Oregon

Sir—In the article on the "Goose Lake Valley Irrigation System, Oregon," by Kenneth A. Heron, in *Engineering News*, Sept. 14, 1916, there were shown detailed plans of three structures on this system.

The writer designed and had charge of the construction of all these structures and feels that some explanation of their design is proper. When the original designs for these structures were first made, the nearest railroad station was at Likely, Calif., nearly 100 mi. from the location of the proposed structures. Being unable to obtain the quantity of lumber required from local mills, I immediately installed a sawmill. During construction the railroad was extended to Lakeview, Ore., and it was then decided to substitute metal flumes for many of the wood flumes originally planned. As a large portion of the lumber had already been sawed, it became necessary to completely revise the plans for nearly all structures and an attempt was made to utilize, as far as possible, the lumber on hand. A well-proportioned structure was not always possible under these circumstances, and this explains the combination of 6x14-in. and 3x12-in. stringers in the first plan shown, and the 3x12-in. longitudinal braces on the substructures for metal flumes, etc.

The pile trestles shown had already been driven for wooden flumes before metal flumes were decided upon, which necessitated the rather complicated substructure for the metal flumes. At locations where pile trestles had not already been driven for wooden flumes a much simpler and more economical structure was erected for metal flumes.

The lining for the flumes and tunnels shown was cut 2½ in. thick, so that, after seasoning, it came from the planer a strong 2 in. This explains why the dimensions shown are not the ordinary commercial dimensions.

I notice an error in the distance shown between centers of the 4x4-in. carrier beams on the metal-flume substructure. As I recall it, these were spaced about 30 in. apart. The dimension shown (10 ft. 2½ in. c. to c.) refers to the distance between centers of holes bored in the carrier beams to receive the carrier rods that supported the metal flume. G. W. RICE.

Investment Building, Los Angeles, Calif.,

Oct. 17, 1916.

The Cost of Running Automobiles used by the Operating Department of the City of San Diego, Calif., is given in the monthly report of S. M. Lockwood, Manager. There are 13 automobiles in use by the Operating Department, which during the month of August made an aggregate of 17,010 mi. The total cost of running these machines, for tires, gas, oil and repairs, during the month was 4.2c. per mi.

Brooklyn Adds an Automatic Sewage-Pumping Station

By L. J. Gersoni*

In providing sewerage systems for newly developed territory in the Borough of Brooklyn, New York City, the Bureau of Sewers has designed and built several pumping stations, both hand controlled and automatic. The latest automatic station to be put into service is located at Avenue U and Ocean Parkway. This station was designed to lift the sanitary sewage from a low-lying area of 739 acres into the gravity system for the district. The present estimated population of this drainage area is about 8,000, or 10.83 per acre. The development will

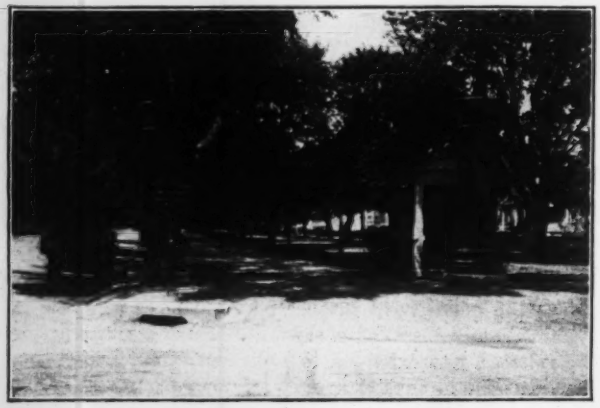


FIG. 1. VENTILATING TOWERS AND ENTRANCE TO PUMPING STATION, AVE. U, BROOKLYN

most likely be residential, with a population of about 100 per acre in 25 years.

At present the average flow to the station is 3.5 cu.ft. per sec., and the maximum 3.7. As the sewers are in water-bearing soil, 0.003 cu.ft. per sec. per acre throughout the day was estimated to be the inleakage, based on data for similar conditions elsewhere. This amounted to 2.2 sec.-ft. running to the station. (After the plant went into service it was found that the infiltration was considerably less—due to careful inspection of the work and extreme care in making the joints of the vitrified pipe.)

Station Equipment

It was judged necessary to have a pumping capacity of 16 cu.ft. per sec., the expected ultimate flow, at the head developed, as the storage capacity of the station well is small. Two 12-in. pumps, each to deliver 3,600 gal. per min. against 31-ft. head, were installed. One will handle the flow up to about the year 1930, when a third or spare unit can be installed, insuring two pumps always ready for service.

The station is under the bicycle path of the parkway and consists of a wet-well, into which the sewage flows, and a dry-well, in which are located the pumps, motors, switchboards, etc. Fig. 1 shows the entrance to the station and also the ventilating towers. The only visible portions are made to harmonize with the surroundings. The sewage passes through bar screens (see Fig. 2) having openings 1 in. wide in the clear, installed merely as a protection for the pumps. These screens are hand-raked periodically, and the small amount of resulting screenings is taken away in closed cans. The three pump suctions pass horizontally through the partition wall, entering the wet-well at the floor level. In operation the well is never pumped dry, the pumps being automatically stopped when there is about a foot of water over the tops of the suction pipes.

The pumps are of a vertical-shaft type, with inclosed impellers, built by the Morris Machine Works, of Baldwinsville, N. Y. They are mounted on chairs on the pumproom floor, permitting the suction connections to be made at the bottom. The suction elbows are provided with hand holes and cover plates to give easy access to the interior of the pump. The upper side covers, including the bearings and stuffing-boxes, are easily removable and on removal expose to view the entire impeller. The pump bearings are positively lubricated by force-feed lubricators driven from the vertical shafts. A small connection from the suction line of each pump is carried to the drainage sump in the floor, so that it can be pumped out and the floor kept dry.

The pumps are driven by 50-hp. two-phase 60-cycle 720-r.p.m. synchronous vertical-shaft induction motors with wound rotors, made by the Fairbanks-Morse Co. It was necessary to use wound rotors in order to keep the inrush current at starting within 150% of the full-load current, this being a requirement of the Flatbush Gas Co., which supplies power for operation. The motors are mounted on sub-bases, which contain the thrust bearings for the pumps. The motor thrust bearings are at the top of the motor frames. The motor and pump shafts are joined by pin couplings so that no part of the pump thrust is transmitted to the motor thrust bearings. All

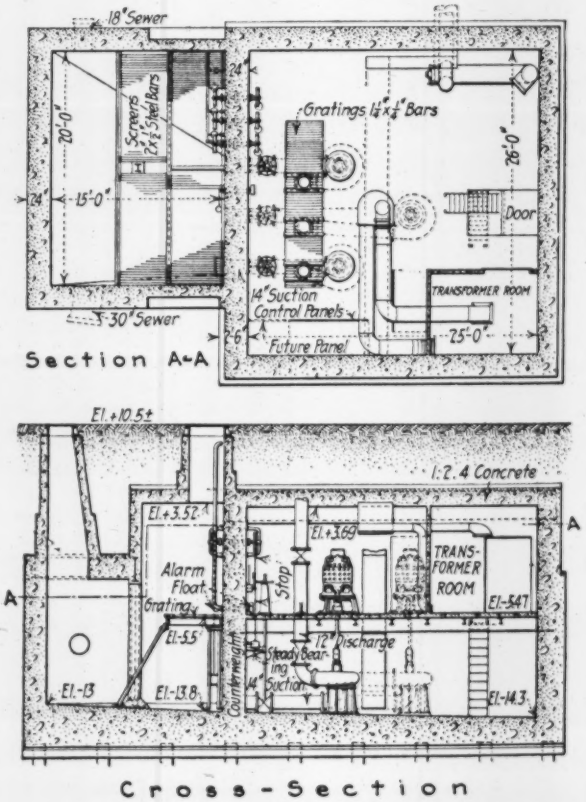


FIG. 2. ELEVATION AND PLAN OF AUTOMATIC PUMPING STATION

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motor windings are impregnated with insulating compound by the vacuum process, to make them suitable for operation in damp places. Lubrication of all bearings is entirely automatic, gages being provided to show the height of oil in all wells.

The pump efficiency is above 60% from 2,750 gal. per min. at 34 ft. head to 4,850 at 22.5 ft. head, with a maximum of 68.5% between 3,600 gal. per min. at 31 ft. head and 4,250 gal. per min. at 28 ft. head, the range of capacity and head developed when both pumps are in operation. With only one pump in operation the capacity is approximately 4,500 gal. per min. at 26 ft. head with an efficiency of 67%. The capacity and efficiency vary throughout an operating period of the pumps as there is an increase of 3.5 ft. static head between the time of starting and stopping of a pump.

Station Operation

Power is carried in by an underground circuit at 2,200 volts, and is transformed in the station to 220 volts for power and 220-110 for lighting.

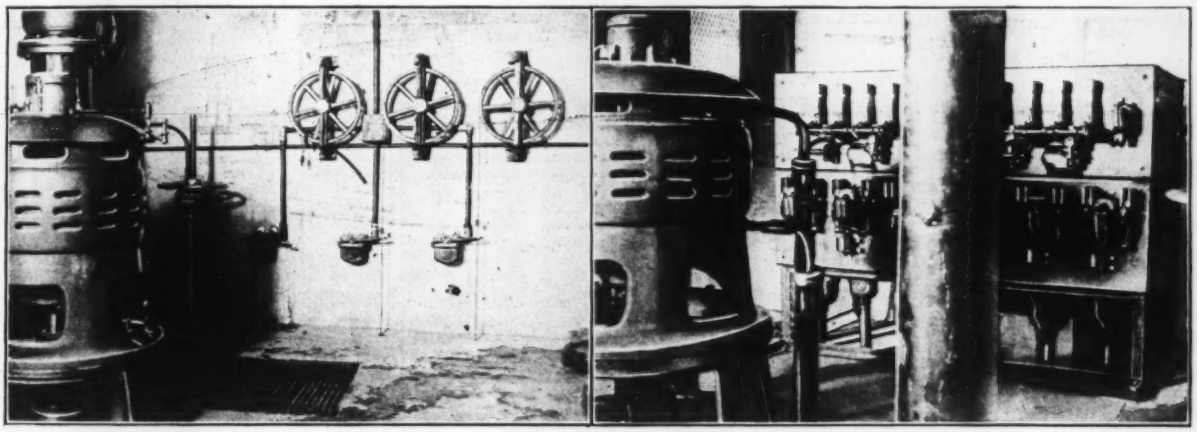
The pumps are started and stopped automatically at predetermined levels of sewage in the wet-well by means of current-limit starters made by the Sundh Electric Co. The float switches controlling the current to the operating coils of the starters are so set that should one pump fail to start or should the flow into the well gain on the pump in operation the other motor will start after the level of the sewage has risen 6 in. above the level at which the first pump should have started. Each starter panel is provided with a Cutter Co. four-pole inverse-time overload circuit-breaker, a magnetically operated primary contactor, and two magnetically operated secondary contactors for cutting out resistance from the rotor circuit. No-voltage release, operated by a coil in each phase, is provided on the starters, so that, should the voltage fail in either phase, the primary and secondary contactors will be open, and on return of voltage the starter will be in proper position to go through a normal starting cycle.

There is an alarm float switch throwing into circuit four Edison-Lalande cells capable of ringing the alarm bell continuously for 24 hr. An interlock on each circuit-breaker is also provided so that the alarm is sounded should the circuit-breaker open. The alarm bell, mounted in one of the ventilating towers, can thus be sounded either by the alarm float switch closing, if the level of the sewage in the wet-well rises to an abnormal height, or by the opening of any of the circuit-breakers on account of some abnormal sustained overload condition in the operation of the pumps. It is intended in the future to arrange the alarm so that it will be sounded at a central operating station where there will be someone in attendance at all hours. For the present, however, the police have been instructed to notify the Sewer Bureau should the alarm be sounded.

Fig. 4 shows one of the motors and the two present starter panels. All coils on the starter panels are impregnated with insulating compound by the vacuum process.

The mechanism for operating the float switches on the control circuits is unique, being a departure from the usual float-chamber type. Cast-iron sleeves, with a stuffing-box at each end, are set in the partition wall between the wet-well and the dry-well. Bronze shafts, with a bearing bracket at each end, pass through these sleeves and carry two drums, one on each side of the wall. Cast-iron floats with bronze shoes, operating in T-bar guides set in the wet-well, are connected by bronze cables to the drums on the wet-well side of the wall. Similar cables, provided with adjustable stops and fastened to the drums in the dry-well, pass through slotted arms on the float switches and carry the counterweights. As the level of the sewage in the wet-well rises and the floats rise, their cables winding up on the wet-well drums, the counterweights sink, their cables unwinding from the dry-well drums. When the stop, in its downward travel, strikes the slotted arm of the float switch, the switch is closed, thus completing the circuit of the operating coil on the motor starter and automatically starting the pump then connected to this particular float switch. The stopping of the pump is accomplished by another stop on the counterweight cable striking the switch arm and opening the float switch when the float in the wet-well has dropped to a lower predetermined level.

It has been found by the Sewer Bureau that this type of float mechanism is more reliable in operation than the separate float-chamber type as it is entirely accessible and at all times exposed to view. Should the float stick or fail to operate for any reason, it can be very easily and quickly put in operating condition again.



FIGS. 3 AND 4. VIEWS IN AVE. U, AUTOMATIC SEWAGE-PUMPING STATION

Fig. 3—Showing motor, float switches, inlet valves, standard and discharge valve. Fig. 4—Showing motor and control switches

Fig. 3 shows one of the motors with its sub-base containing the pump thrust bearing, and the three float-operated switches for controlling the current to the operating coils on the motor starters. Only two float switches—one for each starter—are at present in service. The third will be made operative when the third pump, motor and starter panel are installed. Selector switches on the main switchboard permit any pump and its motor to be controlled by any one of the three float switches. Each starter panel is provided with a normally open, spring-loaded switch to short-circuit the float switch so that the attendant on coming into the station can tell if the pump, motor and starter are in working order without waiting for the float-operated switches to be thrown.

In addition to the integrating power and light meters the main switchboard is provided with a graphic recording voltmeter and a graphic recording ammeter. The former serves as a check on the voltage of the system as maintained by the power company, while the latter shows the operating periods of the pumps and indicates the clogging of a pump by recording a current consumption different from the normal. The switchboard was built by the Sprague Electric Co. All wiring is done with lead-sheathed rubber-covered wire in galvanized steel conduit.

There are two ventilating towers—one for the transformer room and the other for the rest of the dry-well. (In Fig. 1 one tower is shown behind a tree at the left.) For the main-well ventilation, inlet and discharge ducts lead to a ½-hp. motor-driven fan capable of changing the air in 10 min. The inlet and discharge ducts are carried in one tower.

It is found necessary to operate the ventilating system only a few minutes each day, when the attendant calls at the station, in order to keep the air pure and dry and prevent the deposit of moisture on the apparatus.

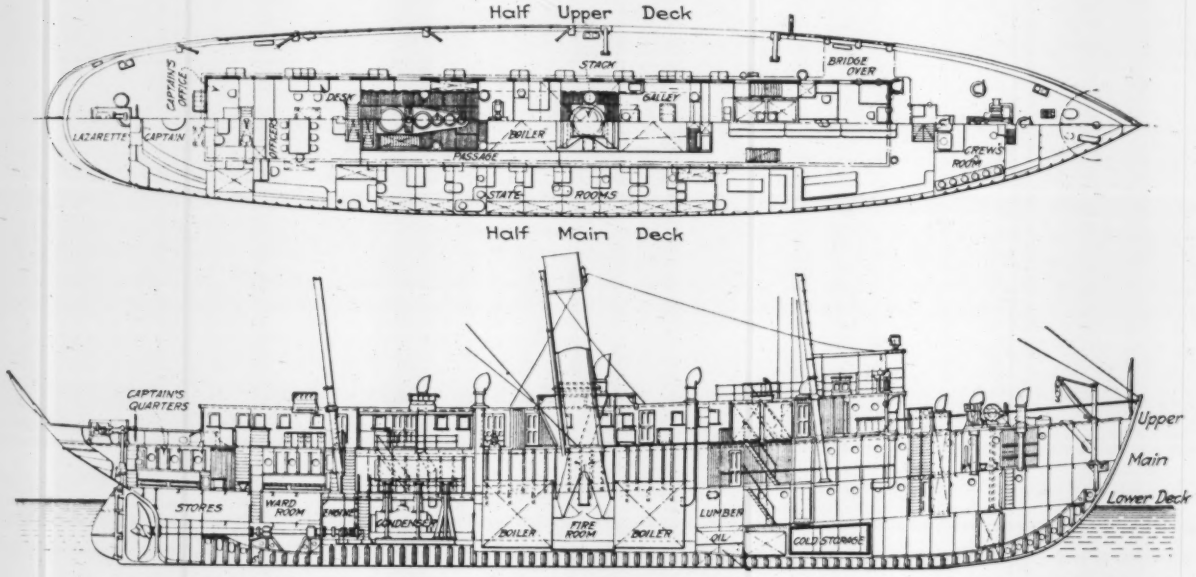
Since the station was put into service in December, 1915, it has operated to the entire satisfaction of the Sewer Bureau. The attendant visits the station each morning, changes the charts on the recording instruments, sees that all lubricators are properly filled and everything is in good working order, and does the necessary cleaning and incidental work about the station. The entire time of his presence at the station is about one hour per day.

The general contractor for the mechanical and electrical equipment of the station was the Almirall Co., of New York. E. J. Fort is the Chief Engineer of Sewers and G. T. Hammond the Engineer of Design.

United States Coast Survey Steamer "Surveyor"

The latest addition to the fleet of the United States Coast and Geodetic Survey is the modern steamer "Surveyor," which was launched last July.

The "Surveyor" is a steel vessel of 1,000 tons displacement. Her dimensions are: Length over all, 186 ft.; length on load water-line, 160 ft.; beam, 34 ft.; depth of hold, 21½ ft.; loaded draft, 12 ft. She will be driven by one triplex-expansion engine of 1,000 hp. and is expected to maintain a 12-knot speed. Through the courtesy of the Bureau of Construction and Repair of the Navy Department a model of this vessel was made and tested in the model tank at the Washington navy yard, and data were furnished for the design of her propeller.



DECK PLANS AND LONGITUDINAL SECTION OF THE UNITED STATES COAST AND GEODETIC SURVEY'S NEW STEAMER "SURVEYOR"

The vessel will carry a complement of 11 officers, who conduct the surveys, and 56 enlisted men. She will burn fuel oil exclusively and will have a tank capacity of 230 tons. She will carry 20,000 gal. of fresh water for the boilers and for general ship use and will have sufficient capacity for mess and ships' stores for about six months.

The "Surveyor" is intended for hydrographic surveying on the Pacific Coast of the United States and Alaska. When completed and equipped at New York she will go by way of the Panama Canal to Seattle, Wash., and from there to the coast of western Alaska.

At the close of the working season in Alaska she will be used for similar surveys on the coast of Washington, ton, Oregon and California. It is expected that this will be her general program of operations for several years—the Alaskan coast during the spring, summer and early fall months and the west coast of the United States during the balance of the year.

The "Surveyor" was designed especially for this duty, and her plans are the result of years of experience with vessels indifferently suited for the work. It is believed that she will be found most efficient and that her design, construction and equipment are as nearly perfect for hydrographic surveying as the appropriation (about $200,000) permitted.

Exceptional seaworthiness, with rugged construction, wide beam and sufficient power to make progress against head seas, are the essential characteristics of the vessel, and in designing her these matters were given more weight than speed and trim lines. The maximum carrying capacity for the displacement was considered necessary in order to provide comfortable quarters for a sufficient crew to make the surveys, and to carry fuel, water and supplies in such quantities as to allow her to remain at sea as long as possible.

The vessel has two full decks and below these, forward and aft of the boiler and machinery compartments, a third deck. These will be referred to here as the upper, main and lower decks. A deckhouse 116x16 ft. extends from 44 ft. abaft the stern to within 26 ft. of the bulwarks aft. The top of this house forms a boat deck that extends to the sides of the vessel. Above the deckhouse are the wheelhouse and the navigator's bridge.

On the main deck are the commanding officer's quarters, the officers' messroom and staterooms, the petty officers' staterooms and messrooms, the hospital space, crew's mess and workrooms and the washrooms and toilet. The crew have quarters in two forecastles on the lower deck forward. All quarters are large and well ventilated, and every possible convenience for the comfort of the officers and men has been provided. Below the lower deck forward and on this deck aft are the storerooms, drinking-water tanks and cold storage. In the deckhouse are the chartroom and executive officer's office, radio rooms, galley and pantries, engineer's office and machine shop, officers drafting room and office and the commanding officer's office.

The main engine is of the vertical, inverted, three-cylinder, triple-expansion, surface-condensing type, with cylinders 18, 29 and 47 in. in diameter and 30-in. stroke. The working steam pressure at the high-pressure cylinder will be 185 lb., driving the engine at 110 r.p.m. The propeller is of cast steel of the built-up type, with four blades. The diameter is 10 ft. 6 in., and the pitch is 13 ft. 4½ in.

Steam is furnished by two Scotch-type boilers, 11 ft. 9 in. in diameter by 11 ft. 11 in. long over all, each fitted with two Morrison corrugated furnaces of 42-in. inside diameter. The boilers are in a compartment just forward of the engine compartment and are placed one forward of the other with the firing space between. The boilers are fitted to burn fuel oil, which is carried in tanks on each side and forward of the boiler space.

The vessel will be lighted by electricity from two generating sets of 10- and 15-kw. capacity respectively. There will be a refrigerating plant of two tons capacity and a steam laundry sufficient for the officers and crew.

The subject of water-tight compartments was given particular consideration in the design, for the reason that this vessel will have to investigate uncharted and dangerous waters. In addition to the usual collision bulkhead at one-tenth her length, she has transverse water-tight bulkheads from keel to main deck on frames 19, 34, 53 and 66 and from keel to lower deck on frame 74. The entire lower deck, both fore and aft, consists of two water-tight flats; and the double bottom in the boiler and machinery spaces, as well as the several oil tanks, which are formed by the shell plating and longitudinal and transverse bulkheads, divides the lower part of the hull into many water-tight compartments.

The boat equipment of a survey vessel is an important consideration, and this vessel has a liberal allowance of boats suitable for surveying operations. These boats are of navy types. They consist of two special hydrographic-surveying launches, 32 ft. long, equipped with 25-hp. medium-duty gasoline engines; one 30-ft. launch with a 25-hp. gasoline engine; one 30-ft. motor sailing launch equipped with a 10-hp. gasoline engine of the navy type; and two whaleboats 20 and 24 ft. long respectively. While all the launches are adaptable for hydrographic surveying, the two 32-ft. special surveying launches are intended to do most of the work, leaving the 30-ft. launch for general use and the 30-ft. motor sailing launch for boating supplies and landing the equipment of camp parties.

The "Surveyor" will carry the usual equipment of a surveying vessel, including machines for sounding at all depths down to the greatest ocean depths. The lighter machines will be electrically driven, while the deep-sea sounding machine will be operated by a steam engine. The radio equipment, which will be the new type of apparatus designed by the United States Bureau of Standards for Government vessels, will be tested and installed by the radio experts of that bureau.

Sanitation on Watersheds

Sanitation on the watersheds utilized for the municipal water-supplies of Newark, Jersey City and New York was the subject of an interesting meeting of the New York Section of the American Water-Works Association, on Oct. 18. The methods of sanitary control and the amount of such control necessary in each instance were described by Morris R. Sherrerd, chief engineer of the Street and Water Commissioners of Newark; Charles F. Breitzke, sanitary engineer of the Jersey City Water-Works, and Theodore De L. Coffin, assistant engineer, Department of Water-Supply, Gas and Electricity, New York City, respectively.

The case of Newark is quite unique. As described in *Engineering News*, May 6, 1915, the city has already purchased more than 60% of the watershed and converted it into forest land, as it is intended to do with the remainder. Jersey City has pursued quite the opposite course, for its supply comes from a drainage area on which are a number of small cities and towns and considerable scattered population, and it relies on a maximum amount of sanitary inspection and chlorination to protect its water drinkers. The conditions on the Croton watershed are not dangerous, but much attention is paid to sanitary inspection.

The discussion of these papers developed three points of particular interest: First, the practical impossibility of enforcing laws and regulations upon an indifferent

public—which all experience; second, the amount of pollution caused by railway passenger trains and whether or not it can be really controlled; and third, the advisability and effectiveness of owning an entire watershed, as in the case of Newark.

Dr. W. P. Mason, of Troy, N. Y., emphasized the point that very few definite data exist on the amount of pollution from railway trains and of the danger that may arise from it. He thought the danger of pollution could be best removed by having a patrolman, or section hand, go over and sterilize any offal found dropped at critical places. The opinions of Alexander Potter and Edward Wegmann, both consulting engineers, New York City, that the money spent in the purchase of watersheds, as in the case of Newark, would be much better spent in filtration plants, met with some applause. It was claimed that depopulating the watershed worked injustice to many property owners; and while it lessened the danger of contamination of the water-supply, it by no means gave positive insurance against it, as would a filtration plant.

News of the Engineering World

George A. Kyle To Build Chinese Railways

The Siems-Carey Railway and Canal Co., owned jointly by the American International Corporation, New York City, and Siems & Carey, of St. Paul, Minn., has concluded a contract with the Chinese Government to build 1,100 mi. of railway, as noted in *Engineering News*, Oct. 5, p. 673. The engineer chosen to take charge of the location and construction of these lines and to supervise operations when the railways are completed is George A. Kyle, an American railway engineer of large and varied experience.

GEORGE A. KYLE

George Allan Kyle was born in the village of Tobasco, Clermont County, Ohio, Sept. 21, 1857. He attended a district school and then went to a business college in Cincinnati. His technical education in engineering consisted of a short course at Holbrook's College, Lebanon Ohio.

His experience in civil engineering began at 16 years of age, in 1876, as a rodman on railway surveys in Ohio and Iowa. In the course of a few years he was promoted to the position of resident engineer. In 1882 he became locating engineer of the South Dubuque & Northwestern Ry., in Iowa. The following year he was division engineer in charge of location and construction of 30 mi. of the Cincinnati & Eastern Ry., near Portsmouth, Ohio.

For the ten years following 1884 Mr. Kyle experienced the usual lot of a railway-construction engineer. His work and travels extended through nearly all the Western States, from Iowa to Oregon and Washington and from the Dakotas to Nevada and California. The principal railways with which he was connected during this time were the Chicago Great Western, Union Pacific, Northern Pacific and Baltimore & Ohio Southwestern.

In 1895 he went to South Africa in charge of surface improvements, the development of some deep-level mines, the building of several miles of railway and a stamp mill, cyanide plant, etc., for the Summer & Jack Gold Mining Co., Ltd., in the Transvaal. Four years later he returned to the United States and was employed by the Northern Pacific Ry. as division engineer in charge of location and construction until 1901. For a year following he was engineer of maintenance-of-way of the Western division. In 1902 he was made division engineer of the Grand Trunk Pacific Ry. in Canada and started 35 parties on preliminary surveys for 2,000 mi. of line. This position he resigned in 1904 and returned to the Northern Pacific on special work.

During 1905 and 1906 Mr. Kyle was in Alaska as engineer of surveys and consulting engineer on construction of the Alaska Central Ry. The next two years he was assistant chief engineer under E. J. Pearson, of the Chicago, Milwaukee & Puget Sound Ry. Since then he has been chief engineer of the Oregon Trunk Ry. and later vice-president and general manager; from 1911 to date he has maintained an office in Portland, Ore., for private practice.

Terminal Railway Gets Another 200-Year Franchise

A franchise running for 200 years, passed by the city commissioners and voted by the people of Kansas City, Kan., has been accepted by the nine railroads involved within the time limit, Oct. 4, 1916, and the Kansas City Terminal Railway Co., grantee, is preparing to start actual construction work amounting to five or six million dollars. This is the same company which received a 200-year franchise from Kansas City, Mo. in 1909, modified in 1911, and has since that time spent about

forty million dollars in regrading, track and terminal work, new Union Station and a number of new street viaducts and subways.

One of the principal pieces of construction work provided for in the Kansas side franchise is the construction of a double track "high line" which will take the passenger-train traffic up out of the congested yards, freight and switch tracks along the Kaw River. One branch of the high line will start near Fifth and Central St. to serve the Missouri Pacific and Chicago Great Western; the other branch will pick up the Rock Island and the Union Pacific trains near Seventh St. and Berger Ave. The two branches will join about 1,000 ft. northwest of the bridge over the Kaw River, the main stem continuing across the river and terminating near 25th St. and Southwest Blvd. in Kansas City, Mo. This high-line structure will have a length of 13,000 ft., of which 5,000 ft. will be filled between concrete retaining walls and the other 8,000 ft. will be of steel viaduct construction. It will be double-track throughout. The present Kaw River bridge will be removed and a four-track double-deck bridge constructed in its place, the high-line viaduct connecting with the upper deck. Freight and some passenger train traffic will be accommodated over the lower deck as at present. The plans for this structure have already been prepared by George E. Tebbetts, Bridge Engineer for the Terminal Company, but no official announcement of the award of contract has yet been made. John V. Hanna is chief engineer.

The franchise also provides for the construction of two union passenger stations, one located at Fifth St. and Central Ave., and the other at Seventh St. and Berger Ave.; each must cost not less than $100,000.

Three new viaducts carrying Fifth, Seventh and Twelfth St. over the Terminal tracks along the north bank of the Kaw River are required to be built. The Terminal Company agrees to pay all of the cost of the viaduct at Fifth St. north of the south line of their right-of-way including an approach at the north end on a 5½% grade. The city will pay one-third of the cost of the viaducts at Seventh and Twelfth St. The Fifth St. viaduct must be completed within two years after the approval of the plans, the Twelfth St. viaduct within one year, and the Seventh St. viaduct within one year.

Provision is also made for the construction of a viaduct over the Terminal Company's right-of-way at Central Ave. to connect with the new Central Ave. bridge, the company agreeing to pay for all of the portion of the viaduct over its right-of-way if it is constructed for vehicles and pedestrains only, or two-thirds of the cost if used by street cars. The company also agrees to construct, maintain and operate a sub-freight station near 19th St. and Kansas Ave., and one near Adams St. and Kansas Ave.

The franchise provides for undiscriminating switching charges equal to those in force in Kansas City, Mo., and for admitting other railway companies in the future to use of the passenger stations upon reasonable terms.

Effect of Hurricane on Corpus Christi Viaduct

The accompanying two views show the effect of the storm of Aug. 18 around the Corpus Christi viaduct, which was described in *Engineering News*, Mar. 30, 1916, p. 698. The view on the left is looking along the line of the railway trestle, which was practically destroyed. The causeway is seen at the right. Fig. 2 is looking along the line of the causeway approach, which, it will be noticed, is also partly destroyed. The railway viaduct is at the right.

The Corpus Christi Causeway, which connects Nueces and San Patricio Counties, Texas, crosses a neck of water 30 mi. inland from the Gulf of Mexico. It consists of a concrete highway bridge 2,532 ft. long and a fill approach 6,200 ft. long, making a total length of 1.66 mi. The bridge part is a series of 76 reinforced-concrete arches, with the piers resting on timber piles, having a concrete cap extending down to the present bottom.

The fill has a top width of 40 ft. with 1 on 6 side slopes, which approximate the natural beach slopes of the sand spits at each end of the causeway. This entire fill is novel in that it is of oyster shell placed by hydraulic dredging from a shell reef that underlies the entire structure. The slopes are protected by continuous mats of brush faggots built into the toes of the fill and on the exposed side by a heavy apron of riprap.

The experience in the recent storm only duplicates that of a year ago at the Galveston causeway and shows that an overtopping flood has the same effect on a bridge-approach fill as it has on an earth dam; that is, it is practically certain to destroy it. The tide level during the Corpus Christi storm was approximately 2 ft. below the floor of the causeway, but the waves covered the entire structure. Although subjected to the very heaviest waves and the pounding of timbers from the railway trestle, the concrete part was undamaged, not even a spindle in the rail being cracked. The shell fill, however,

FIG. 1. LOOKING ALONG THE LINE OF RAILWAY TRESTLE AT CORPUS CHRISTI

FIG. 2. PARTLY DESTROYED APPROACH FILL TO THE CORPUS CHRISTI CAUSEWAY

was two-thirds destroyed, with a loss of about $30,000. The fill will be rebuilt, because the saving in interest on the concrete construction will pay for the rebuilding in three or four years' time. The rebuilding will be in charge of the engineering firm of Bartlett & Ranney, of San Antonio, which also had charge of the original construction of the bridge.

Bridge and Building Men Meet at New Orleans

The annual convention of the American Railway Bridge and Building Association was held at New Orleans, Oct. 17 to 19, in the Grunewald Hotel. The meeting was called to order by President G. W. Rear, Southern Pacific Co. The report of Secretary C. A. Lichty showed a balance of $1,240 in the treasury. Members attending the convention numbered 148, and 58 new members were admitted into the society.

A number of papers and reports were presented on fuels, paints, floors for shops and roundhouses, modern methods of driving piles, waterproofing roofs of wooden buildings, efficient handling of men, passenger stations, handling concrete, and small coaling stations.

In its report the Committee on Fuels for Internal-Combustion Engines (C. R. Knowles, C. A. Lichty, J. Dupree, J. J. Murphy) states that, weight for weight, oil can be stored in a smaller space than coal, one ton (2,000 lb.) of bituminous steaming coal occupying approximately 40 cu.ft., whereas a ton of oil occupies 35 cu.ft. Considerable attention is given to fuels suitable for heavy-oil engines. The heavy-oil engine is a comparatively recent development and is being used extensively in railway water stations. The most popular engine of this type is the 50-hp. two-cycle.

The Committee on Caring for and Handling Creosoted Timber (E. T. Howson, J. S. Lemond, F. D. Mattos) states that the Louisville & Nashville R.R. was the pioneer in this work and still has in service in teredo-infested waters along the Gulf of Mexico a large number of piles treated in 1876. At the timber-treating plant of this railway at Gautier, Miss., which treats bridge timbers only, a carpenter shop has been installed at which all the timbers are completely framed before they are treated, thus reducing to a minimum the cutting of the timber after treatment. Similarly on the Santa Fe, where large numbers of treated-timber box drains and culverts are used, the timber is framed and sawed to the length desired before being treated. On the Philadelphia & Reading Ry. the chief engineer furnishes the creosoting plant with the details and framing instructions for all timber used on new construction work, and this timber is framed at the creosoting plant before being treated. So far as possible a similar arrangement is carried out for the maintenance-of-way work. Included in this committee report are the Illinois Central rules to be followed in handling creosoted material.

The Committee on Station Buildings for Passenger Service Only (M. A. Long, E. B. Ashby, G. W. Andrews, J. B. Gaut) states that one of the main features to be kept in mind in designing a railroad station is the maintenance cost and recommends the use of brick, stucco or concrete. The better buildings should be roofed with tile or slate, and these materials should be used for slopes of 6 in. per ft. or over. Composition roofs, asbestos shingles and tin are used to a limited extent, but they are not recommended for the better-class structures. One of the principal problems in a station is the floor surface. Wood holds and absorbs the dirt, while varnish is soon scratched and worn off by the cinders carried in by passengers. Where wood is used, it should be either maple or edge-grain pine. Composition floors are used extensively and give a hard, impervious surface; but their wearing qualities are not altogether satisfactory. Floor tile should be vitrified in order to wear satisfactorily.

The report of the Committee on Efficient Methods of Handling Work and Men (F. E. Weise, E. R. Wenner, S. C. Tanner, J. F. Pinson) starts off with the following words of wisdom: "We are sometimes apt to wonder if the words 'efficient' and 'efficiency' have not been overworked, but when we cast about for synonyms we find that they will not do; so we use these words over and over again." This report consists of data on a number of construction operations, with especial regard to bridge building.

On Friday, Oct. 20, an enjoyable excursion was taken by special train to Bogalusa, La., 72 mi. north of New Orleans. A stop was made to inspect the 6-mi. trestle over Lake Pontchartrain, also stopping at Slidell for a trip through the Southern Creosoting Works. At Bogalusa an inspection was made of the Southern Lumber Co.'s sawmill.

The following officers were elected for the ensuing year: President, C. E. Smith (T. & P.), St. Louis; vice-presidents, E. C. Ashby (L. V.), New York City; S. C. Tanner (B. & O.), Baltimore; Lee Jutton (C. & N. W.), Madison, Wis.; F. E. Weise (C. M. & St. P.), Chicago; secretary-treasurer, C. A. Lichty (C. & N. W.), Chicago.

Strong Talk About Utilities

Privately owned public utilities and the relations of the National Electric Light Association and engineering professors thereto were the subjects of a strong talk by Morris L. Cooke, Director The Utilities Bureau, Philadelphia, Penn., in an address on "The City and Its Utilities" before the League of Kansas Municipalities last week. Mr. Cooke called attention to a new method by which utility properties were being sapped, naming the engineering profession as the means. In one case he said a firm of engineers in the East were being paid 2.7% of the gross receipts for management and 10% additional on the design and construction of all new work. He scored the National Electric Light Association as the essence of invisible government, claiming that a bare 100 men controlled the entire policy of its 14,000 members and stated that it was perilous to thwart the purposes of the Association. He foresaw a virulent storm brewing in the utility field. He called particular attention to the "social significance" of deans and professors in our engineering colleges appearing on the side of private corporations as rate experts and recommended that they be compelled to file as a public document a complete record of any such employment, giving charges collected, terms of employment, etc. Although our colleges are sound at the core, he said, they need guarding. "In rate cases," he urged, "the private interests side is developed by the capital resources of the entire country and states and municipalities should combine to fight in the same way."

Dam Fails for Third Time at Schenectady

A small earth dam belonging to the Schenectady Milling Co. and located at Veeder's Pond, Schenectady, N. Y., failed at 12:28 a.m., Friday, Oct. 20—flooding the surrounding streets and premises, and causing considerable damage by wrecking barns and flooding cellars. The flood wave was high, but of short duration. All the damage was done within 100 ft. of the break. One horse was quickly swept away from his hay pile, but as quickly stranded in a neighbor's store of celery.

VIEWS OF VEEDER'S POND, SCHENECTADY, AND WASHED-OUT DAM

Two previous failures of earth dams at this spot are known to have occurred—both many years ago. The earlier failures probably were as serious as this last one, but excited no comment, as they happened before the affected areas became built up. All three failures were due to faulty design.

The cross-section of the dam, as exposed by the washout of Oct. 20, shows a bottom width of about 60 ft., a top width of about 10 to 15 ft. and a center height of between 25 and 30 ft. The side slopes are about 1 on 1. The total length of the embankment was about 150 ft. About 80 ft. of top width was washed out.

The dam was built up of loose sand with a double plank cutoff wall near the upstream top angle. These planks extended on the left-hand side of the dam, only to within 6 or 8 ft. from the top, as shown at the left in the accompanying view, and to a lesser height on the right-hand side.

The pond has been gradually filled up with sediment to a depth of 12 to 15 ft. near the dam, leaving only a few feet depth of water to the level of the waste gate. This gate is some 4 or 5 ft. below the top of the embankment. High-water marks on the banks indicate a maximum depth of about 6 or 8 ft. of water in the pond at the time of failure. The normal pond area at waste-gate level is about one acre. The view at the right in the accompanying illustration shows the erosion of the sediment in the pond by the flow in the creek after the break occurred.

The failure was caused indirectly by an intense rainfall early in the evening of Oct. 19. The nearest rain gage, at the R. E. Horton Hydraulic Laboratory, about 6 mi. southwest, indicated a fall of 0.85 in. in about 2 hr., following a lighter fall of 0.26 in., which had thoroughly soaked the area tributary to the stream. Apparently there has been built up in the extension of Schenectady's population an impervious layer over the light sandy soil of this locality. Otherwise such a rain would have been discharged more gradually. The 2.6 sq. mi. of drainage area about the dam site is very sparsely wooded; in the lower reaches the stream has very steep banks, but the upper area is flatter and covered with a light growth of brush.

Apparently the direct cause of failure was the overtopping of the fill by the impounded waters. There was no spillway in the dam, a waste gate on a 6-ft. pipe being the only outlet for the stored water. This gate was closed.

⁂

Barge Transportation on the Mississippi River is to be established by the Aluminum Co. of America. This company has purchased 11 large steel barges from the American Steel and Wire Co., each 200 ft. in length, 36 ft. in width and 10½ ft. draft, built by the American Bridge Co. at Ambridge in 1911. The Aluminum Co. is to use the barges for the transportation of material from mines in Arkansas to its plant at East St. Louis.

Standard Plans for School-Building Construction especially designed to reduce the fire risk, are to be framed by the Committee on School House Standardization of the National Educational Association. The Chairman of the committee is Frank Irving Cooper, Architect, of Boston. The committee desires to obtain for use in its work the standards already adopted for school building construction by states, cities, and trade organizations.

Port Improvements at Girardot, Colombia, in the Magdalena River are soon to be started in accordance with a law enacted in 1913. The President of Colombia has appointed an honorary board which with the assistance of an engineer will supervise the work, the plans having been approved by the Minister of Agriculture and Commerce. Girardot is of particular importance as a shipping point because it is the only port connected by rail with the City of Bogota and moreover connects with the Polima Ry. running to Espinal.

A Prize Offer to Engineering Students is announced by the Chicago Association of Commerce. The prizes offered are $50, $30 and $20 for the best three papers not exceeding 3,000 words on any one of the following subjects: (1) "Engineering and Civic Progress"; (2) "The Engineer of the Future"; (3) "The Business Relation of the Engineer to the Commercial World." The contest is open to graduates of 1915 and 1916, or undergraduates of any recognized American engineering school. The papers are to be judged by F. H. Newell, John W. Alvord and John M. Hayford. Papers offered for the prizes should be mailed to Engineers Subdivision Contest, Chicago Association of Commerce, 10 La Salle St., Chicago, and must be received not later than Nov. 1, 1916.

An Official Straw Vote is to be taken at Pomona, Calif., in order to determine whether the citizens are in favor of a bond issue, amounting to $200,000, for flood protection work. The

City Council will arrange for taking the straw vote by appointing one citizen to stand near each polling place in the city at the general election on Nov. 7. He will ask each voter appearing at the polls whether or not he will vote in support of a bond issue if an election to vote on it is called. It will be necessary to have an official election to ratify the bond issue in case the majority of voters are found to be in favor of it, but it is planned by the straw vote to test the public sentiment in advance, so that in case a majority are adverse to the bond issue, the expense of a special election may be saved.

A Flood Conference in Pennsylvania has been called by Governor Brumbaugh, to be held on Oct. 31, for general discussion of ways and means to control the waters of Pennsylvania. Acting at the request of the Pittsburgh Flood Commission, the Governor has invited the mayors and presidents of councils and of chambers of commerce of Philadelphia, Pittsburgh and Scranton, members of the State Water-Supply Commission, the state commissioners of health, forestry and officials of water-power companies, as well as the president of the Ohio and Lake Erie Ship Canal Board, the Allegheny County Commissioners, the officials of the United States Geological Survey in the State, and General Kingman, of the Corps of Engineers, U. S. Army, to attend.

Calorific Value of Gas, instead of candle-power, has been established as the standard by the Public Service Commission for the Second District, State of New York. All companies making more than 20,000,000 cu.ft. per year of coal, water or mixed gas must show a product averaging 585 B.t.u. per cu.ft. Smaller concerns may adopt the standard but it is not compulsory for them. The change has been made to accord with the development of the gas industry which is toward consumption in bunsen-burner apparatus where the usefulness depends on heat content and not on candlepower of an open flame. The cost of oils introduced into ordinary gas to raise the candlepower has greatly increased as the utility of the enrichment has diminished. The illuminants formerly introduced condensed to a considerable extent in the longer transmission and distribution pipe lines which have become necessary.

Orders for Planting Ocean Islands are wanted by an enterprising and imaginative Oriental if a story published in the Boston newspapers is true. According to this story, a postcard was received at the Boston post office addressed "Stock Exchange or Chamber of Commerce, care of Chief Police Officer." The inscription on the card is as follows:

Notice. My rights ot the oceans, being first claimant thereto, in respect of planting islands on Mid-Atlantic and on other oceans to serve as cities or otherwise to the world by my patent or by other manner, have been proclaimed by Heavenly Spirits throughout the world in June, 1916. Confirmation thereof could be given. Offers are invited. Tan Hong Poh, 57 Hill street, Singapore, S. S., 4th Aug., 1916.

It is reported the postcard bore the stamp "Passed by Censor." What more could one ask regarding the validity of the claim to the right of planting islands in the mid-Atlantic or any other part of any ocean, or the ability of the claimant to execute his designs?

Plans for Converting the Site of the Panama-Pacific Exposition, San Francisco, into a residence park are being drawn by Mark Daniels, landscape engineer, Monadnock Building, San Francisco. To make the project feasible, the owners of a large part of the land have decided to combine their holdings. The general plan, as thus far conceived, provides for laying out a part of the district with radial and circular streets to comprise slightly over half of the area of a circle. Streets tangential to the circular streets of half this semicircular area and making acute angles with the tangents of the other ends of the circular streets, with cross-streets at right angles in each case, would comprise the layout of a triangular area based on the semicircular area. In the outlying districts a few main thoroughfares laid out in such directions as to free the entire district from the usual monotonous checkerboard city plan are proposed. Further property adjustments are necessary before the plan can be completed, and it is expected that the Palace of Fine Arts will be preserved and that the California Building will be utilized for a State Normal School.

Geared Turbines will replace direct-connected turbine units on all ships so equipped in the American Navy. This is being done because the Navy Department is convinced that the higher-speed geared machines are lighter, take up less space, are mechanically superior, reduce the steam consumption—particularly at cruising speeds, and increase the steaming radius. The first two ships to be reëngined are the destroyers "Henley" and "Mayrant." Contracts have been placed with the Westinghouse Machine Co., of East Pittsburgh. The "Henley" was built by the Fore River Shipbuilding Co. in 1912. The main machinery consisted of two direct-connected marine turbines with two compound cruising engines which were connected to the main turbine shafting by means of jaw clutches. The turbines had 14 ahead and two reverse stages. Steam was supplied to the turbines at a pressure of 250 lb. by water-tube boilers for which oil was used as fuel. The new machinery will consist of two complete-expansion geared-turbine units of the impulse-reaction type with Kingsbury thrust bearings, and two geared cruising units. It is to be installed in the same engine-room space and to connect with the existing propeller shafting, and drive the propellers at the same speed as formerly. The two cruising turbines will each have a capacity sufficient to move the ship at a speed of 15 knots. They will be connected to the main turbines by clutches and will be used only up to a speed of 15 knots. After this speed has been attained they will be disconnected and the main turbine alone used. Reduction gears will reduce the turbine speed of 3,000 r.p.m. down to 640 for the propeller shaft. The "Mayrant" was built by the William Cramp & Sons Ship and Engine Building Co. in 1911. The old machinery consisted of two turbines without cruising engines. The turbines were designed to develop 13,000 shaft horsepower at a speed of 650 r.p.m. and with a steam pressure of 250 lb. gage. They had 16 stages ahead and 7 stages astern. Steam was supplied by four water-tube boilers. Oil was used for fuel. The new machinery to be furnished will be essentially the same as that for the "Henley." The main turbines, however, will each have a capacity of 7,000 shaft horsepower at a propeller speed of 629 r.p.m. The speed of the turbines will be 3,000 r.p.m.

PERSONALS

Hollie Ford has been elected County Road Engineer of Greaves County, Kentucky, at a salary of $1,600 per annum.

W. P. Barba, M. Am. Soc. M. E., has resigned as Vice-President of the Midvale Steel Co., after 36 years' connection with the company.

W. B. Crawley, of Abbeville, Ala., has been appointed Superintendent of Roads of Houston County, succeeding the late W. E. McEachern.

W. M. Ackworth, of London, England, has been appointed a member of the Railway Board of Inquiry of Canada, to succeed Sir George Paish, resigned.

M. H. Mooney has been appointed County Engineer of Grundy County, Missouri, to succeed W. E. Ralls, resigned. The county offices are at Trenton, Mo.

H. L. Cumming, has been appointed Chief Engineer of the Guantánamo & Western R.R., with headquarters at Guantánamo, Cuba, succeeding R. A. Lyman.

Harry Bowers, County Road Engineer of Ohio County, West Virginia, has resigned to become General Superintendent of the Ball Engineering Co., of Wheeling, W. Va.

E. Herbert Dunmire, Assoc. M. Am. Soc. C. E., City Engineer of Lawrence, Kan., has been appointed Superintendent of the city water-works also, the two positions having been combined.

Jiro Komiya, Electrical Engineer for the Imperial Japanese Government, is in this country to study recent practice in electric-power transmission and distribution. He is now in the Northwest.

H. W. Dow, for the past 12 years associated with the engineering and sales department of the Nordberg Manufacturing Co., Milwaukee, Wis., has been appointed Sales Manager of the company.

J. M. Giles, Assoc. M. Am. Soc. C. E., Supervising Engineer of the Porto Rico Irrigation Service, has been promoted to be Chief Engineer to succeed J. W. Beardsley, whose resignation was noted in these columns, Sept. 14.

John C. Wheelon, Chief Engineer of the Utah-Idaho Sugar Co., of Garland, Utah, was awarded the Harrison Gray Otis prize cup at the International Irrigation Congress for his paper on "The Agricultural Duty of Water."

Charles Gillman Hyde, Professor of Sanitary Engineering, has been appointed Acting Dean of the College of Civil Engineering, University of California, to temporarily succeed Prof. Charles Derleth, Jr., who is on leave of absence.

Cleveland A. James, Assoc. M. Am. Soc. C. E., recently in charge of the Buffalo terminal construction work for the Lehigh Valley R.R., has resigned to enter private practice as Consulting Engineer, with an office in Buffalo, N. Y.

William B. Voth, recently Chief Engineer of the Syracuse & South Bay Electric Railroad Co., Syracuse, N. Y., has been appointed Manager of the Ogdensburg (N. Y.) Gas, Power and Light Co. He is an electrical-engineering graduate of the University of Wisconsin.

Charles B. Sadler, Assoc. M. Am. Soc. C. E., has resigned as Engineer in charge of the pitometer survey of the Baltimore (Md.) Water Department. From 1909 to 1915 he was Designing Engineer of the storm-water division of the Baltimore Sewerage Commission.

Louis D. Fouquet, Division Engineer in charge of the Sewer Division of the Public Service Commission, First District, New York, has resigned, and the Sewer Division has been abolished. This work is now being handled by the different Division Engineers of Construction.

Charles J. Carroll, M. Am. Soc. C. E., of Towanda, Penn., has been appointed Assistant Chief Engineer of the proposed Chinese Government railways to be constructed by the Siems-Carey Railway and Canal Co. Mr. Carroll is a graduate of Yale University and for several years was with the engineering staff of the National Railways of Mexico.

William Mendowcroft, for the past 10 years Assistant Engineer of the Board of Water-Supply of the City of New York and formerly with the Department of Public Works of the Philippine Islands and the Metropolitan Water Board of Massachusetts, has volunteered for field service with the American Ambulance Corps in France. He sailed for Paris on Oct. 14.

Alfred Craven, M. Am. Soc. C. E., Chief Engineer of the Public Service Commission, First District, New York, in charge of all rapid-transit construction in New York City, has been appointed Consulting Engineer at a salary of $12,000 per annum, effective Nov. 1. His salary as Chief Engineer is $20,000, said to be the highest salary paid to any public-works engineer. The change is made at Mr. Craven's own request.

Carl E. Akeley, inventor of the cement gun, has been awarded a John Scott Legacy Medal and Premium by the City of Philadelphia, acting on the recommendation of the Franklin Institute. The award is made in recognition of a device "which has proved to be of great value for waterproofing dams, reservoirs, coating structural work, houses, etc." Mr. Akeley is a sculptor, naturalist and explorer, with the American Museum of Natural History, New York City.

Arthur E. Loder, Division Engineer of the California State Highway Commission has resigned his position and has been appointed Assistant Chief Engineer of the U. S. Office of Public Lands. He will have charge of the construction of highways in the National forest reservations under the one million dollar appropriation recently made by Congress. Mr. Loder was formerly connected with the Land Office and later was for four years Chief Engineer of the Los Angeles County Highway Commission.

Charles W. Okey, Assoc. M. Am. Soc. C. E., Senior Drainage Engineer, United States Office of Public Roads and Rural Engineering, has resigned to take charge as Chief Engineer of the drainage and development of a tract of land at Whitehall, S. C., owned by the Combahee Co., of Charleston, S. C. It will be a pumping project similar to those of southern Louisiana. Mr. Okey has been in charge of drainage investigations for the Government in the southern Louisiana district for the past seven years.

H. E. Stevens, M. Am. Soc. C. E., whose appointment as Chief Engineer of the Northern Pacific Ry. was noted in these columns Sept. 28, was born at Bluehill, Maine, Mar. 8, 1874. He was graduated from the University of Maine in 1897. For three years he was with Ralph Modjeski, Consulting Engineer, Chicago, Ill. He entered the employ of the Northern Pacific Ry. in 1904 in the bridge department. He was appointed Bridge Engineer in 1907, which position he held until his present promotion.

John V. N. Dorr, President of the Dorr Cyanide Machinery Co., New York City, has been awarded a John Scott Legacy Medal and Premium by the City of Philadelphia, acting on the recommendation of the Franklin Institute. The award is made in recognition of his invention of hydrometallurgical apparatus—"the Dorr classifier, for separating quick-settling or sandy material from slow-settling or slimy material, when both are suspended in a liquid, and the Dorr thickener, for thickening or dewatering slimy material in suspension."

Daniel Lawrence Turner, M. Am. Soc. C. E., Deputy Engineer of Subway Construction, Public Service Commission, New York, First District, has been appointed Acting Chief Engineer, effective Nov. 1, to succeed Alfred Craven, appointed Consulting Engineer, as noted elsewhere. Mr. Turner is a graduate of Rensselaer Polytechnic Institute, class of 1891, and for nine years was Instructor in surveying, railway engineering and hydraulics at Harvard University. He has been associated with New York City rapid-transit construction work since the beginning of the subways in 1900 under the Rapid Transit Commission. Upon the establishment of the Public Service Commission in 1907 he was appointed Division Engineer of Stations and Chief of the Bureau of Transit Inspection. Since 1912 he has been Deputy Engineer of Subway Construction. A portrait and biographical sketch were published in "Engineering News", Oct. 8, 1914, in connection with a series of articles on the subway construction. Mr. Turner's salary as Acting Chief Engineer will be $12,500 per annum.

OBITUARY

Lawrence M. Thacher, a civil engineer with the Georgia Railway and Power Co., Atlanta, Ga., died Oct. 15. For several years he was with the engineering staff that extended the Florida East Coast Ry. to Key West. He was born in Yarmouth, Mass., and was graduated from the Massachusetts Institute of Technology in 1886. Most of his engineering experience had been in the South. He was President of the Atlanta section of the Engineering Association of the South.

ENGINEERING SOCIETIES

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 30-Nov. 4. Annual meeting at La Salle Hotel, Chicago. Secy., J. A. Andreucetti, C. J. N. W. Ry., Chicago.

AMERICAN MINING CONGRESS.
Nov. 13. In Chicago, Secy., J. F. Callbreath, Munsey Bldg., Washington, D. C.

AERO CLUB OF AMERICA.
Nov. 13. Annual meeting in New York City. Secy., Wm. Hawley, 297 Madison Ave., New York City.

NATIONAL COMMERCIAL GAS ASSOCIATION.
Nov. 13-18. Convention in Atlantic City, N. J. Secy., Louis Stotz, 61 Broadway, New York City.

RICHMOND RAILROAD CLUB.
Nov. 13. Annual meeting. Secy., F. O. Robinson.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting in New York City. Secy., D. H. Cox, 29 W. 39th St.

ELECTRIC POWER CLUB.
Nov. 15-17. Annual meeting in Hot Springs, Va. Secy., C. H. Roth, 1410 W. Adams St., Chicago.

KANSAS GOOD ROADS ASSOCIATION.
Nov. 16-17. Annual meeting in Lawrence Society headquarters in Kansas City.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 16. Annual meeting in Atlanta, Ga. Secy., A. J. Merrill, P. O. Box 1205, Atlanta.

CITY MANAGERS' ASSOCIATION.
Nov. 21-23. Convention in Springfield, Mass. O. E. Carr, Niagara Falls, N. Y.

NATIONAL MUNICIPAL LEAGUE.
Nov. 23-25. Annual meeting in Springfield, Mass. Secy., C. R. Woodruff, 705 North American Building, Philadelphia.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The Canadian Society of Civil Engineers has grown in membership to 3,076, according to the year book for 1916. There are 8 honorary members, 693 members, 1,409 associate members, 34 associates, 357 juniors and 575 students.

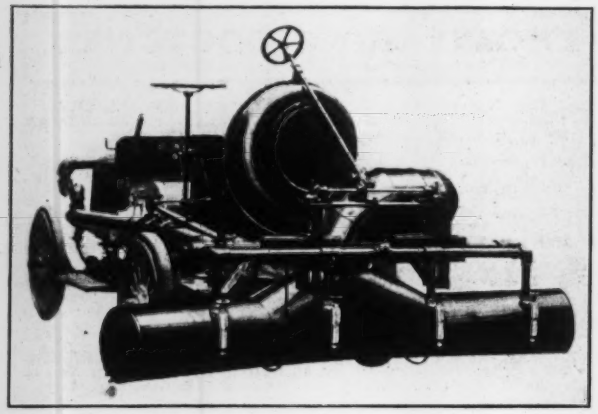
The American Road Builders' Association will hold its annual meeting in New York City on Nov. 3, at the Automobile Club of America, 247 West 54th St. In the evening a dinner will be held in the grillroom of the club, at which short addresses are promised. The attendance at the dinner will not be limited to members; a general invitation is extended to all interested in the good-roads movement.

The Four-State Section of the American Water-Works Association will hold its next meeting in Wilmington, Del., on Nov. 15. Members arriving in the morning should go directly to the Hotel Du Pont, from which they will be taken by automobiles to inspect the new reservoir and filtration plant now under construction. Following this, luncheon will be served at the Du Pont at 1:30 p.m., followed by a short business session. The secretary is Charles R. Wood, P. O. Box 363, Philadelphia, Penn.

Appliances and Materials

Macadam Cleaner and Bitumen Spreader

A machine for removing the dirt from the top courses of stone roads and applying hot bitumen in fine sprays has been devised by S. E. Finley, of Atlanta, Ga., and made the basis of a proprietary system of bituminous-macadam road building and repair by a penetration process (known as the "Finley Method"). A motor-truck chassis, as shown in the accompanying view, carries a large blower, chain driven from the transmission shaft and delivering 6,000 cu.ft. of free air at 2 or 3 oz. pressure to a pipe header carried across the rear of the truck. This flue has a wide longitudinal slot just forward of the bottom. Back of the air distributor are four special rotating nozzles that are supplied with the hot binder at 60 lb. per sq.in. pressure. A small air compressor supplies air to the tank truck (used in front of the distributor truck to carry the supply). When this outfit is in service, the dust on and in the road is blown into the air and the bitumen applied before the fine material has had a chance to settle. Any application from the lightest to the heaviest (from less than ¼ to



FINLEY BITUMEN SPREADER

over 2 gal. per sq.yd.) is claimed possible with uniform distribution.

These machines are not sold, but are leased, or work with them is done on contract. It is reported that the cost of application on this basis is about 6c. per gal. Several contracts have been taken at 25c. per sq.yd. of roadway for 1½ gal. of asphalt furnished and applied in two coats.

* * *

New Use of Graphite-Babbitt Bearings

The use of graphite inserts in babbitted bearings has been adopted by the Jeffrey Manufacturing Co., of Columbus, Ohio, for its power-transmission, conveying, elevating, crushing and screening equipment. This is reported to allow reduction in the amount of oil and to give improved service under the severe operating conditions and neglect to which this class of apparatus is subjected.

The graphite cones are pressed in place on a fine copper screen that is inserted in the bearing boxes before the babbitt is poured.

* * *

New Type of Barrel Elevator

The accompanying illustrations show a method of handling oil barrels which has been adopted by the Standard Oil Co. at its works in Milwaukee, Wis. The machine elevates empty barrels from the wash house and delivers them to an inclined skid, on which they roll by gravity a distance of about 100 ft. to the filling room. The special feature of the machine is that it is able to pick up the barrels from a curved chute underneath the foot sprocket.

A diagram of the equipment, showing the elevator in relation to the skids with the barrel arm in the discharging position is given in Fig. 1. Fig. 2 shows the elevator frame with the curved receiving chute at the bottom. The barrel arms are descending.

The barrels are rolled out of the tank at the right-hand side of the picture, Fig. 2, and the arm picks them up one at a time as it sweeps around the bottom of the chute. The barrel arm is attached to two strands of chain belt, which carry it around the head and foot sprockets. The arm is of the automatic discharge type which trips by means of a pair of cams engaging the ends of the curved lever arms that carry the barrels. These cams are placed on the upcoming side of the elevator just below the opening in the wall through which it is desired to discharge the barrels. The chain belt is provided with suitable attachments for the crossbars of the barrel arm, and the whole is mounted on a structural-steel

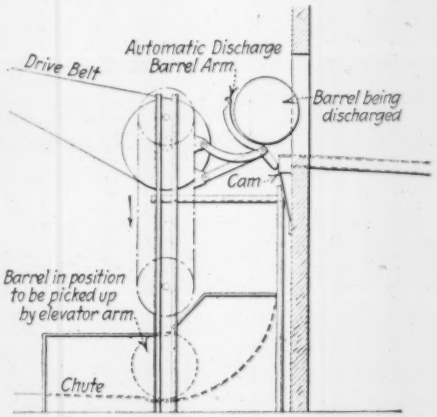


FIG. 1. BARREL ELEVATOR WITHOUT LOADING PIT

frame with necessary guides for the chain belt and supports for the shafting.

One of the advantages claimed for this type of construction over the common design of barrel elevator is that no deep pit is necessary under the foot sprockets, and the equipment is particularly adapted to conditions where it would not be possible to have any part of the machine extend below the floor line.

About 1 hp. is required for driving the elevator, and the power is taken from a lineshaft in the building by means of a belt coupled on to the elevator countershaft. The capacity of the machine is 120 barrels per hour. It was designed and manufactured by the Chain Belt Co., of Milwaukee, Wis.

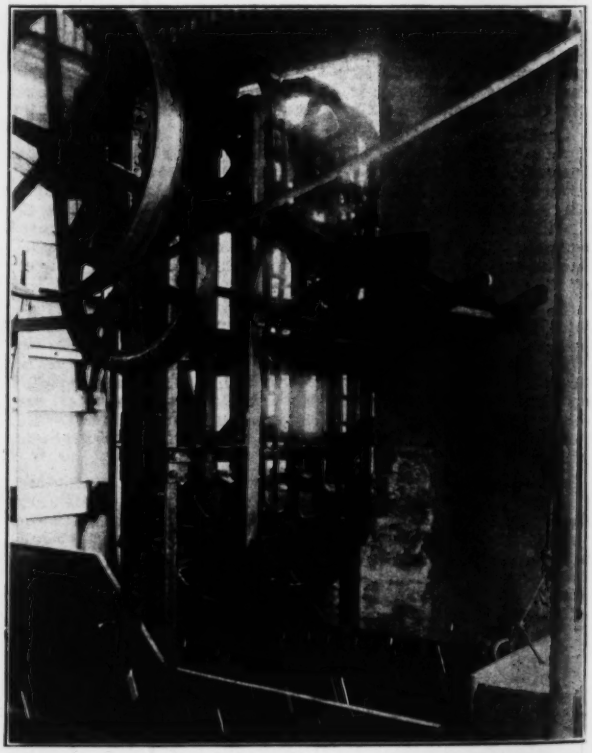


FIG. 2. CHAIN-BELT BARREL ELEVATOR, STANDARD OIL CO. PLANT, MILWAUKEE